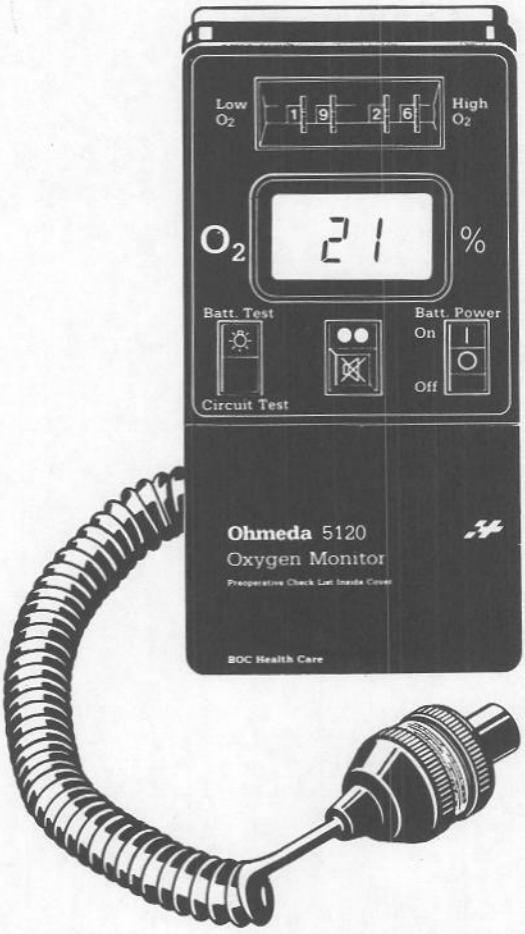
Ohmeda

5120 Oxygen Monitor
Service Manual



Addendum to the 5120 Oxygen Monitor

Service Manual Stock Number
0178-0164-000 (04 87 B)
For Contract Number DLA120-87-C-4281

NOTE: Storage Inspection Requirements - Inspection of units in storage should be performed at 30 month intervals. Use MIL-STD 105D for unit sample size. Follow the Preoperative Checkout Procedure in Section 3 of the 5120 Oxygen Monitor Operation and Maintenance Manual (Ohmeda Stock No. 0178-1757-000).

NOTE: Perform preventative maintenance for units in service quarterly (every 4 months). Follow the Preoperative Checkout Procedure in Section 3 of the 5120 Oxygen Monitor Operation and Maintenance Manual (Ohmeda Stock No. 0178-1757-000).

NOTE: Storage Inspection Requirements - Inspection of units with oxygen monitor sensors should be performed at 12 month intervals. Use MIL-STD 105D for unit sample size. Follow the Preoperative Checkout Procedure in Section 3 of the 5120 Oxygen Monitor Operation and Maintenance Manual (Ohmeda Stock No. 0178-1757-000).

NOTE: The 5120 Oxygen Monitor should be stored in a clean dry enviroment with temperatures not to exceed -28°C to +54°C (-20°F to 130° F).

NOTE: To maximize the oxygen monitor sensor's shelf life, when refrigeration is not available, the sensor should be stored in a clean and dry enviroment at:

Temperature: -20°C (68°F) +/- 2°C
Humidity: 55% +/- 5%

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Service Manual

5120 Oxygen Monitor

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Important

The information contained in this service manual pertains only to those models of products which are marketed by Ohmeda as of the effective date of this manual or the latest revision thereof. This service manual was prepared for exclusive use by Ohmeda service personnel in light of their training and experience as well as the availability to them of parts, proper tools and test equipment. Consequently, Ohmeda provides this service manual to its customers purely as a business convenience and for the customer's general information only without warranty of the results with respect to any application of such information. Furthermore, because of the wide variety of circumstances under which maintenance and repair activities may be performed and the unique nature of each individual's own experience, capacity, and qualifications, the fact that customer has received such information from Ohmeda does not imply in any way that Ohmeda deems said individual to be qualified to perform any such maintenance or repair service. Moreover, it should not be assumed that every acceptable test and safety procedure or method, precaution, tool, equipment or device is referred to within, or that abnormal or unusual circumstances, may not warrant or suggest different or additional procedures or requirements.

This manual is subject to periodic review, update and revision. Customers are cautioned to obtain and consult the latest revision before undertaking any service of the equipment. Comments and suggestions on this manual are invited from our customers. Send your comments and suggestions to the Manager of Technical Publications, Ohmeda, Ohmeda Drive, Madison, Wisconsin 53707.

CAUTION: Servicing of this product in accordance with this service manual should never be undertaken in the absence of proper tools, test equipment and the most recent revision to this service manual which is clearly and thoroughly understood.

Technical Competence

The procedures described in this service manual should be performed by trained and authorized personnel only. Maintenance should only be undertaken by competent individuals who have a general knowledge of and experience with devices of this nature. No repairs should ever be undertaken or attempted by anyone not having such qualifications.

Genuine replacement parts manufactured or sold by Ohmeda must be used for all repairs.

Read completely through each step in every procedure before starting the procedure; any exceptions may result in a failure to properly and safely complete the attempted procedure.

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⚠ CAUTIONS:

This monitor contains electronic components that are susceptible to damage by electrostatic discharge. When disassembling the monitor, work at a static control workstation; wear a static control wrist strap to discharge accumulated static charges from you and any tool you are using. Handle the circuit boards by their nonconductive edges. Use an anti-static container for transport.

INTRODUCTION

This manual contains information that will help a technically competent individual to maintain the Ohmeda 5120 Oxygen Monitor in proper operating order and, when service is required, to restore it to meet published specifications.

If you are not familiar with the 5120 Oxygen Monitor, read the Operation and Maintenance Manual (0178-1757-000) to learn how the monitor is used and what routine maintenance can be performed.

The monitor contains electronic components that are susceptible to damage by electrostatic discharge (ESD). To guard against damage by ESD, service the monitor only at a static control workstation.

System Installation (Modulus II Anesthesia System)

The 5120 Oxygen Monitor is a stand-alone unit that can be carried from place to place as required. Its compact size makes it an ideal module for use in larger systems such as the Modulus II Anesthesia System.

When used as a stand-alone unit the monitor operates from internal batteries. When used in a Modulus II Anesthesia System, the system provides power through the Sensor input connector.

To determine the monitor's condition, functional tests (section 3.2) can be performed while the monitor is still installed in the system; however, calibration, troubleshooting, and repair require that the monitor be removed from the system.

Software Versions

This manual is based on monitors using Software Version 3.0. Where applicable, separate notes refer to differences encountered with earlier revision level monitors.

Notable differences between Rev. 3.0 and earlier Software revisions are:

- The original microprocessor used in the 5120 Oxygen Monitor includes masked ROM memory for program storage. Beginning with Rev. 3.0 software the microprocessor includes EPROM memory, instead.

- In units with Rev. 3 software, silencing of an alarm, causes any flashing indicator (LED) to cease flashing (on continuously) for the duration of the alarm silence period.

- For Rev. 3 Software, a Low O2 alarm sounds whenever the oxygen level fall below 18%, rather than 10% as found in earlier revision software.

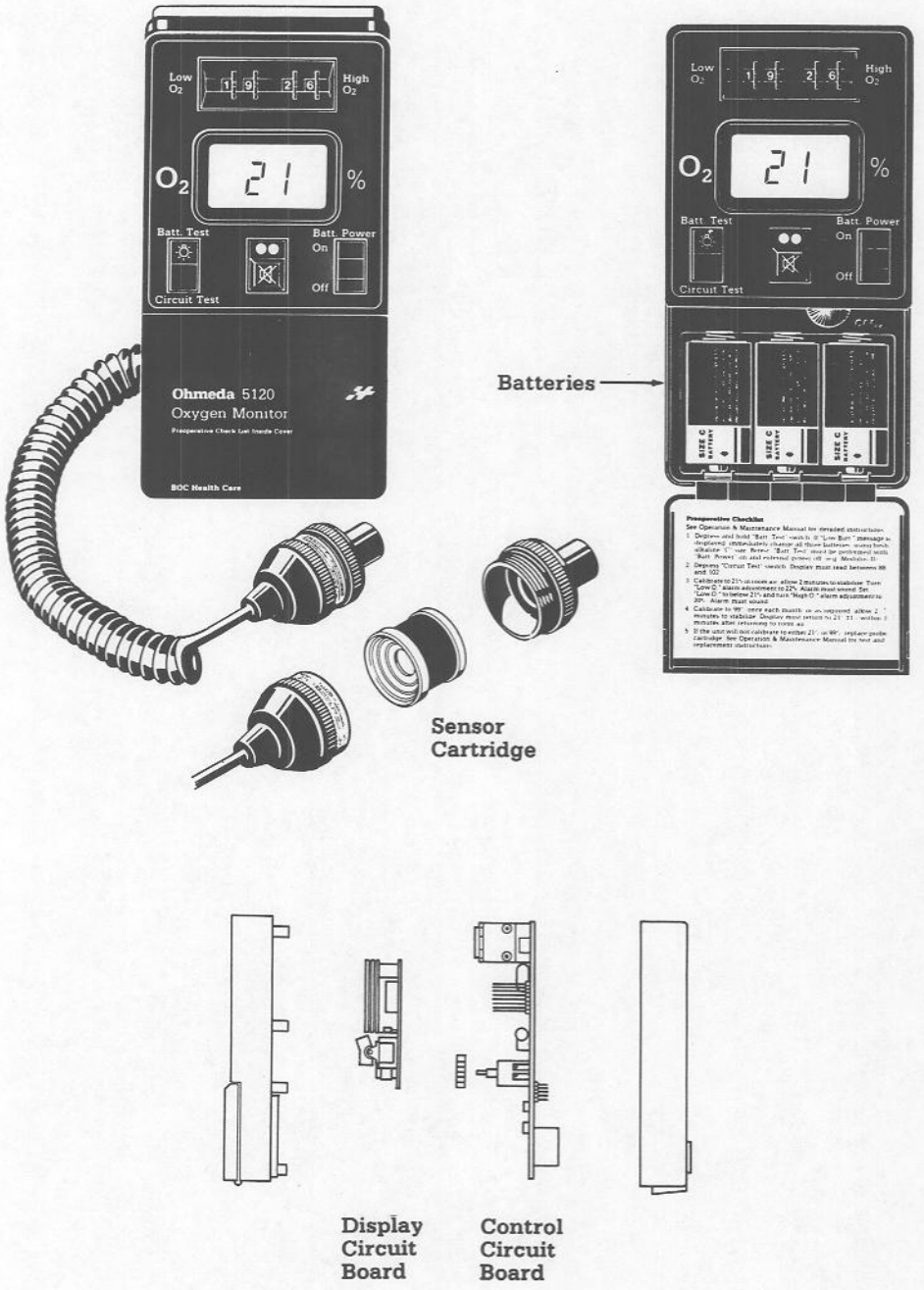

Figure 1. Ohmeda 5120 Oxygen Monitor:
includes standard accessories as listed in section 1.4.

1.0 DESCRIPTION

The 5120 Oxygen Monitor displays oxygen concentrations from zero to 100 percent. It produces audible and visual alarms to indicate

- that the displayed value is greater than or less than operator selected High O2 or Low O2 alarm limits,
- that the sensor is disconnected or defective,
- that the batteries require replacement.

1.1 General Features

Refer to Figure 1.

The monitor uses a Sensor Cartridge (galvanic) that produces a current which is proportional to the oxygen concentration (partial pressure) at its sensing surface. The sensor does not require periodic attention and, when required, can be replaced without tools.

All of the monitor's circuitry (except for batteries) is contained on two printed circuit boards that remove easily for troubleshooting and repair.

The Control board uses a microprocessor to control all functions of the monitor (except for watchdog timer). The Display board contains driver circuits for the backlit LCD display and is used for mounting the front panel switch controls (except for alarm limit control).

Three, size C, alkaline batteries power the monitor when used as a stand-alone unit. (When installed in a Modulus II Anesthesia System, the system supplies power to the monitor through an intermediate cable that connects the sensor cable (at patient interface) to the monitor.

The monitor includes a battery test (automatic and manual) that displays the condition of the batteries (if still useable) or generates alarms to indicate that the batteries require replacement. The batteries are easily accessible for replacement behind the hinged access cover.

To compensate for reduced output of the sensor as it ages, the operator calibrates the monitor to room air (21%) whenever the monitor is put into use. The accuracy of the displayed readings over the full range (linearity) can be checked using a single concentration of oxygen (greater than 99% is specified).

All displays are produced on a single liquid crystal display (LCD) that is part of the Display board.

The alarm indicator LEDs (light emitting diodes) are part of the alarm silence switch and must be replaced as a unit.

The monitor includes a self-test feature (System Test Mode) which is used to verify proper operation of the monitor (Functional Checkout Procedure; section 3.2) and can be used as an aid in troubleshooting.

1.2 Model Variations

A single model of the 5120 Oxygen Monitor is available to cover all applications. Accessories are provided to facilitate its use as a portable unit, to mount it in a permanent location, or to use it in dedicated applications.

When used as a portable unit (or mounted in a location that has no provisions for an external power source) internal batteries are used as a source of power. When used in a dedicated application, such as in a Modulus II Anesthesia System, power is supplied by the system to extend battery life.

1.3 Accessories

Several Standard Accessories are supplied with the oxygen monitor as shown in Figure 2. Note that the probe holder and the universal mounting clamp are not included with monitors that are built into the Modulus II Anesthesia System.

A dome adapter kit and a sensor cord extension kit are available as Optional Accessories; refer to Figure 3.

A. Standard Accessories:

The 22 mm Tee Manifold adapts the 15 mm sensor probe to the patient airway circuit.

If the monitor is to be used as a portable unit, the probe holder provides a convenient place to keep the sensor probe when not in use.

If the monitor is to be used in a "permanent" location (not built into a system), the universal mounting clamp is used to attach the monitor to a convenient shelf or pole.

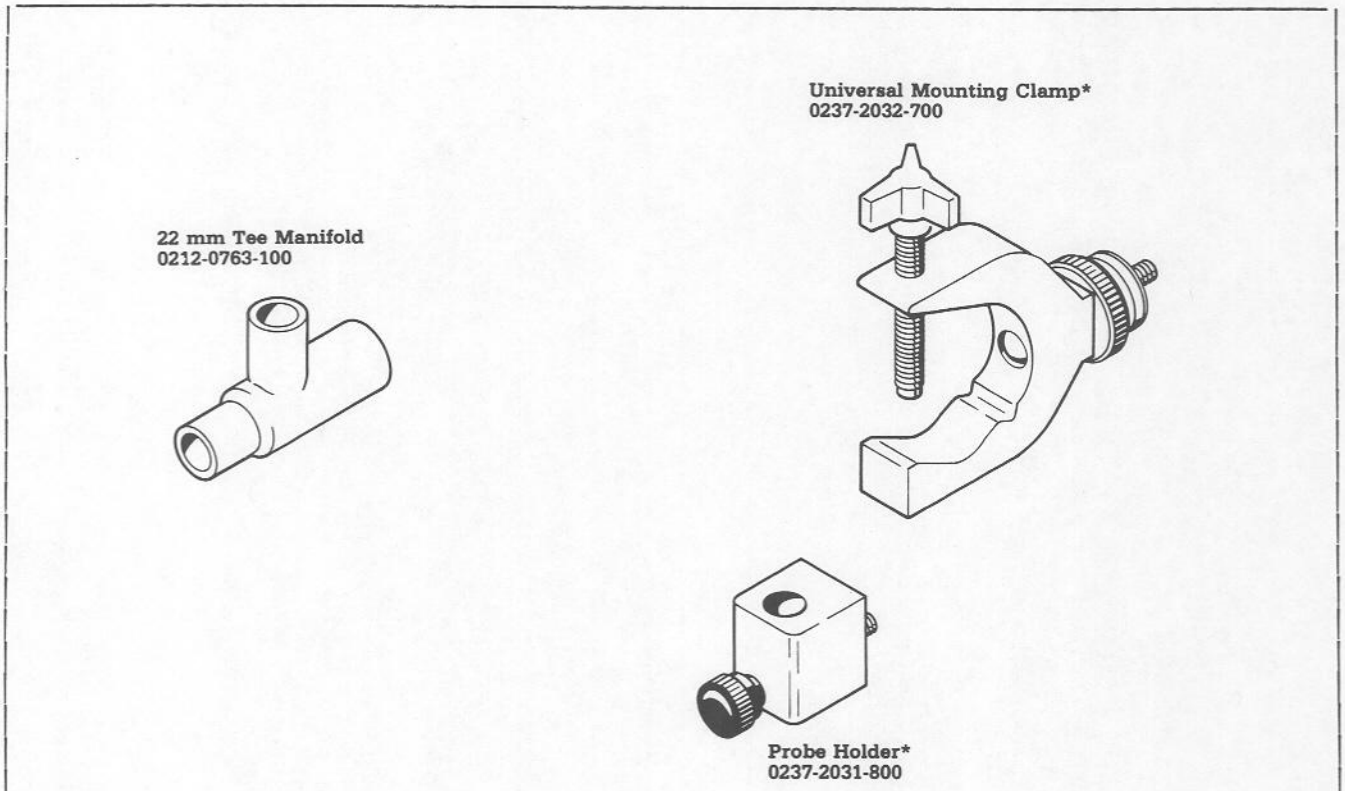

Figure 2. Standard Accessories
Items marked with asterisk (*) are not supplied with system installations.

B. Optional Accessories:

The Dome Adapter Kit provides a patient airway sensing port at the Inhalation Check Valve of an Ohmeda Model 20 or 21 Absorber.

The Sensor Cord Extension Kit increases the reach of the Sensor Assembly by six feet (12 feet total).

The six-pin Duplex Jack allows two parallel connections to the monitor's Output connector for special applications.

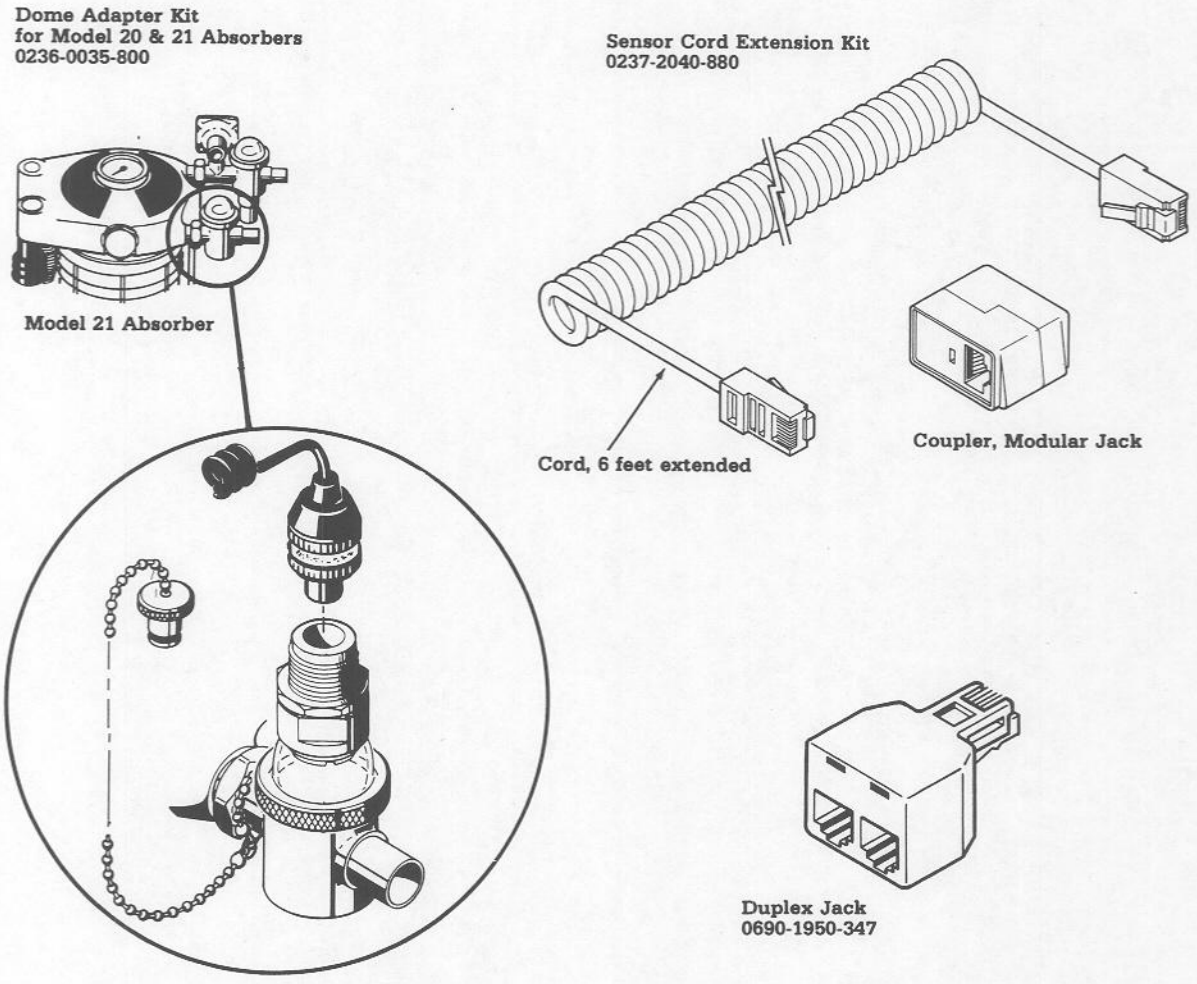

Figure 3. Optional Accessories

1.4 Specifications

NOTE: Unless otherwise indicated, all specifications are nominal, and subject to change without notice.

Performance Specifications:

These specifications are valid only if the monitor is properly calibrated as detailed in section 3.0.

DISPLAY TYPE:	LCD (Liquid Crystal Display)
RANGE:	0 to 100% Oxygen
DISPLAY RESOLUTION:	1% of full scale reading
DISPLAY UPDATE:	3 times a second
RESPONSE TIME, TYPICAL:	90% of total change in oxygen concentration in less than 20 seconds at 25 °C (77 °F)
DRIFT RANGE:	+/- 1% over an 8 hour period
MONITOR LINEARITY:	+/- 1% of full scale
OPERATING TEMPERATURE RANGE:	+5 °C to +40 °C (41 °F to 104 °F)
TEMPERATURE COMPENSATION RANGE:	+15 °C to +40 °C (59 °F to 104 °F)
SENSOR LIFE:	12 months, typical; assumes average % O2 equal to 50% at +25 °C (+77 °F)

ALARM SYSTEM:

- VISUAL
  - -- Alphanumeric messages indicating oxygen concentration out of selected limits: HIGH O2 and LOW O2.
  - -- Alphanumeric messages indicating battery condition: BATT OK and LOW BATT.
  - -- Continuously lit or intermittently flashing alarm indicators (red or yellow Light Emitting Diodes - LEDs) determined by alarm condition.

- AUDIBLE
  - -- Oscillating two-tone (2 kHz/1 kHz),
  - -- continuous low tone (1 kHz),
  - -- intermittent low tone, or a
  - -- 3-beep low-tone,

  determined by alarm condition.

- ALARM SILENCE
  - -- For Low O2 condition, the audible alarm can be silenced for 30 seconds, only.
  - -- For conditions other than Low O2, the alarm can be silenced for the duration of the alarm condition.
  - -- Silencing an alarm causes any flashing alarm indicator (LED) to remain lit continuously (not flashing) for the duration of the alarm period.

- ALARM LIMIT LESS THAN 18%

  Setting the Low O2 alarm limit below 18% results in three beep tones and a continuously lit alarm indicator (yellow). Although the Low O2 alarm limit can be physically set to below 18%, the monitor issues a LOW O2 alarm whenever the O2 level falls below 18%, regardless of the low limit switch setting.

  Note: For monitors with software revisions prior to Rev. 3.0, the alarm sounds when oxygen falls below 10%.

POWER REQUIREMENTS: Three, size C, alkaline batteries

DRAIN: Typical current, 3.5 milliamps at 4.5 volts (assumes no alarms or use of backlight)

BATTERY LIFE, NOMINAL: 1300 hours; eight weeks continuous use (24 hours a day); (assumes no alarms or use of backlight)

BATTERY TEST: Manual and Automatic

ANALOG OUTPUT: 10 mV/%O2 at 10 K ohms minimum load impedance

DIMENSIONS: Depth: 6 cm (2.25 inches)
Width: 9 cm (3.50 inches)
Height: 17 cm (6.75 inches)

WEIGHT: 0.6 kg (1.3 lbs) without sensor

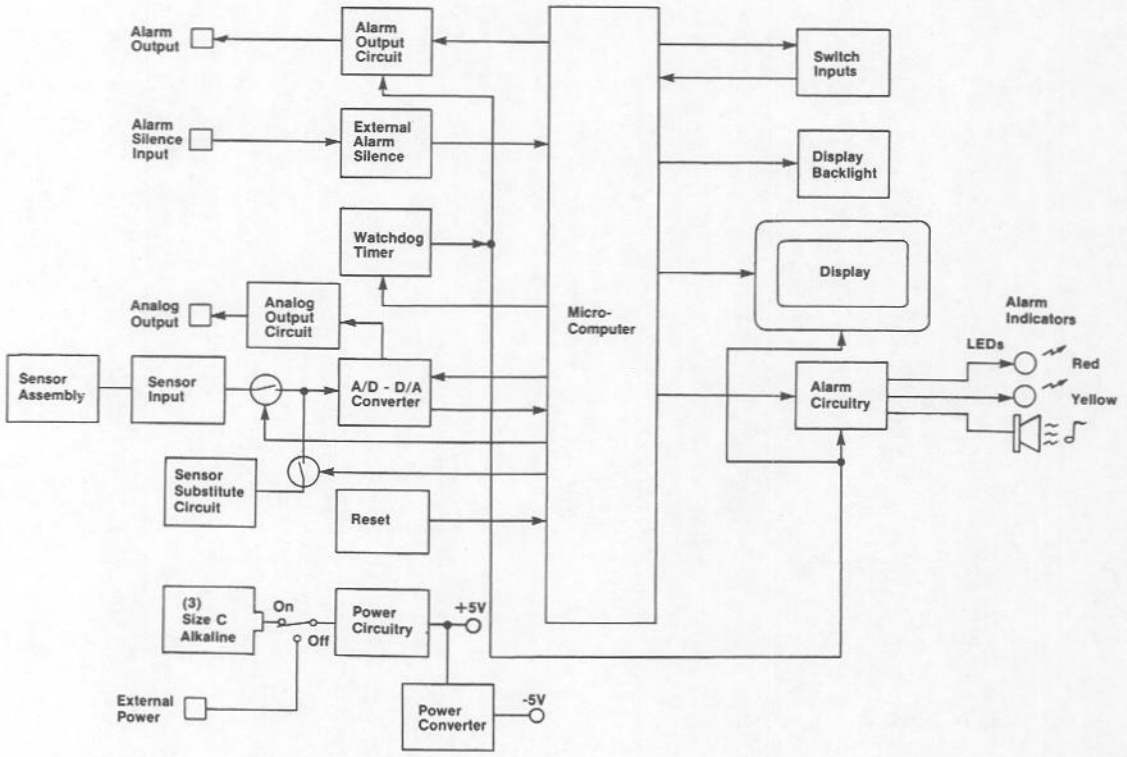

Figure 4. 5120 Oxygen Monitor, Block Diagram

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2.0 THEORY OF OPERATION

This manual assumes that the reader is, in general, familiar with the operation of microprocessor controlled systems. The theory deals with functional circuit blocks located on one or the other circuit board (Control - Display) or, in some cases, split between the two boards. The theory discusses signals which the circuits generate (output) or which the circuits use (input) to achieve the various functions of the monitor.

The relationship between these blocks is shown in Figure 4 and described in the following list.

- **Power Supply Circuits** . . . . . (section 2.1) . . . . . Page 2-3
  Converts battery power (or power from an external source) to a plus 5 volt and a minus 5 volt supply.

- **Microcomputer** . . . . . (section 2.2) . . . . . Page 2-4
  Controls all operations of the monitor (except for watchdog timer).

- **LCD Display** . . . . . (section 2.3) . . . . . Page 2-6
  Converts digital information from the microprocessor to its alphanumeric equivalent.

- **Backlight** . . . . . (section 2.4) . . . . . Page 2-8
  Improves display visibility in low ambient light.

- **Front Panel Switches** . . . . . (section 2.5) . . . . . Page 2-9
  Low O2, High O2, Batt Test/Backlight (☼), Circuit Test.
  (For Batt Power On/Off refer to section 2.1.)

- **Sensor Input** . . . . . (section 2.6) . . . . . Page 2-10
  Converts the input from the sensor (current proportional to oxygen concentration) to a proportionally varying voltage.

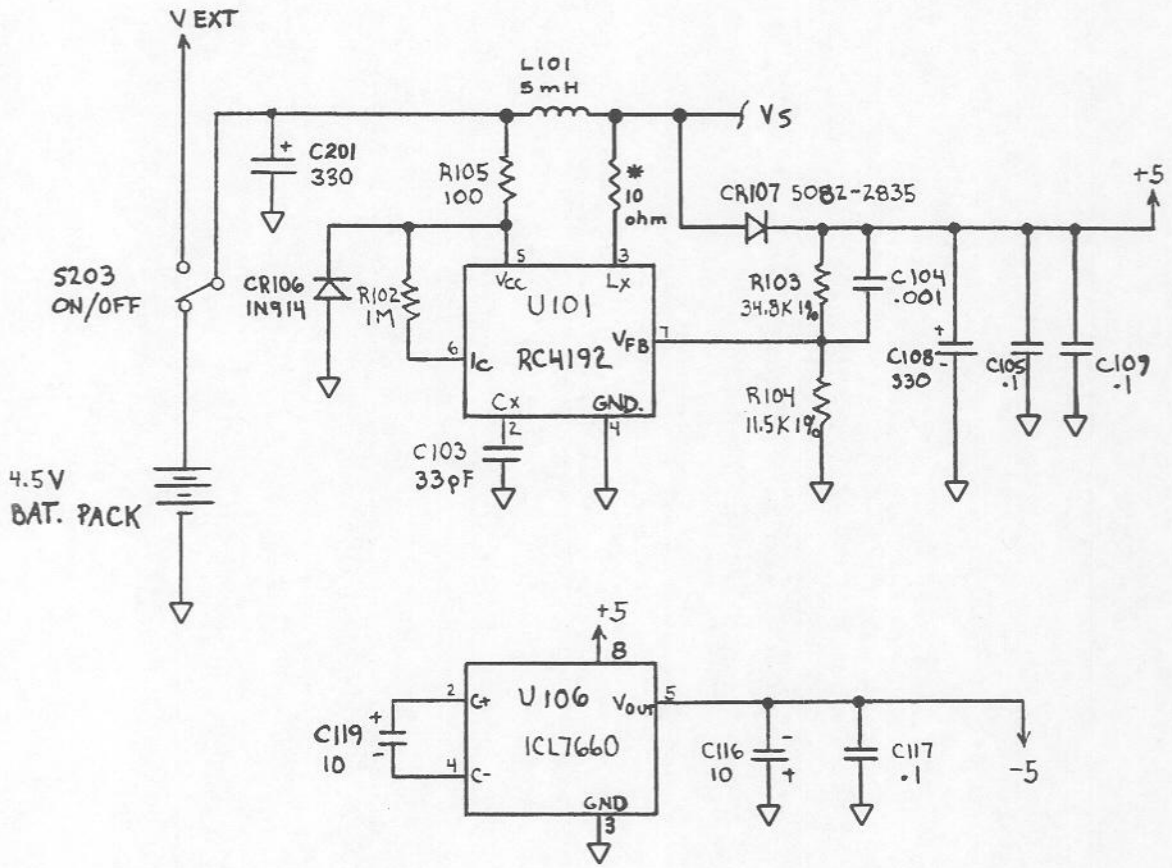
- **A/D - D/A Converter** . . . . . (section 2.7) . . . . . Page 2-12
  Converts the sensor voltage to its digital equivalent (A/D). Converts digitized oxygen concentration value to its analog equivalent (D/A) for remote monitoring (Analog Output).

- **Alarm and Alarm Indicators** . . (section 2.8) . . . . . Page 2-14
  Generates audible alarms and visual alarm indicators based on microprocessor, operator and "Watchdog" circuit inputs.

- **Watchdog Timer** . . . . . (section 2.9) . . . . . Page 2-15
  Issues an alarm condition if a system (monitor) failure is sensed.

- **Alarm Output** . . . . . (section 2.10) . . . . . Page 2-16
  Alarm output for remote monitoring

- **Analog Output** . . . . . (section 2.11) . . . . . Page 2-18
  Produces a voltage proportional to the oxygen concentration for remote monitoring.



* Note: This 10 ohm resistor may be present in some units. If not, the junction of L101 and CR107 is connected directly to pin 3 of U101.

Figure 5. Power Supply Circuit

2.1 Power Supply Circuit:

To operate properly, the monitor requires a constant +5 volt supply. Since the monitor is powered by batteries whose combined terminal voltage can vary from 4.5 volts when fresh to 3.0 volts when considered discharged, a DC-DC power converter is used to boost the voltage to the required level.

The DC-DC converter is designed around U101 (RC4192), a switching regulator. The circuit builds up a magnetic field in inductor L101 by connecting it to ground through a transistor switch in the 4192 regulator. When the output voltage falls below a fixed value (R103/R104), the transistor switch opens causing the magnetic field around L101 to collapse. The collapsing field generates a voltage which is added to the applied voltage. The higher voltage charges capacitor C108 through diode CR107. When the output voltage rises above the fixed reference, the transistor switch is again turned on to recharge the inductor. This process is repeated rapidly to maintain the specified +5 volt output.

Diode CR107 is a Schottky diode used to improve the efficiency of the power supply. Regular silicon diodes conduct at about 0.6 volts. The Schottky type diode conducts at about 0.2 volts.

Resistor R105 and diode CR106 protect the system if the batteries are inadvertently installed backwards.

Some items in the monitor do not require a regulated voltage. They are connected directly to the switched power input (Vs). These items include the backlight, the audible alarm circuits, and the LED alarm indicators.

In addition to the +5 volt supply, a negative voltage is required for the operational amplifiers and the D/A converter. Component U106 is a voltage converter which converts the +5 volts applied to it to a -5 volt supply.

2.2 Microcomputer:

Component U102 is a CMOS, single-chip microcomputer (1468705 - EPROM or 146805 - ROM); it is a complete computer system containing random-access memory (RAM) for storing variables, fixed memory (EPROM or ROM) for the software program, 32 I/O lines for input/output functions, and a programmable timer.

Figure 6 shows the microprocessor's external connections. Figure 7 lists the function of each I/O port.

Microprocessor Reset

Power-on reset is normally handled by circuitry in the microprocessor. The external circuitry connected to the RESET line insures that proper reset occurs during momentary power cycling (as when the power switch is turned off and on rapidly).

Components CR114, C123, and C115 form a small power supply. If the main supply voltage (+5 volts) drops by more than 1.2 volts, Q105 turns on which turns on Q104, forcing a reset of the microprocessor.

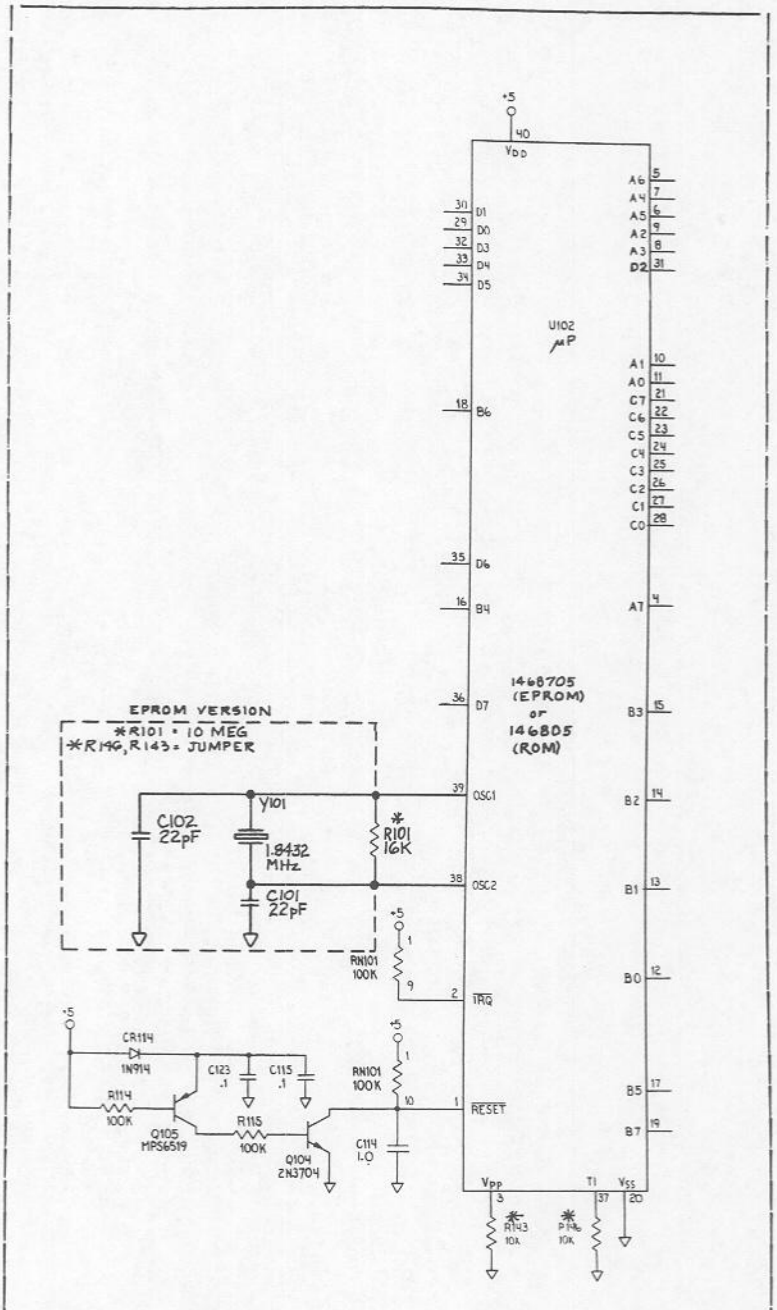


Figure 6. Microcomputer

Port A:

A0	output	D/A bit 8
A1	output	D/A bit 9
A2	input	Sensor voltage comparator output
A3	input	Battery voltage comparator output
A4	output	Analog switch, connects sensor to amplifier
A5	output	Analog switch, grounds input to amplifier
A6	output	Analog switch, connects reference voltage to amplifier
A7	output	Analog switch, sample/hold

Port B:

B0	input	Bit 0 of BCD switch inputs
B1	input	Bit 1 of BCD switch inputs
B2	input	Bit 2 of BCD switch inputs
B3	input	Bit 3 of BCD switch inputs
B4	output	Yellow LED; 1 is on, 0 is off
B5	input	External Alarm Silence, rising edge triggered
B6	output	Watchdog Timer output
B7	output	Alarm output, 1 = alarm condition exists

Port C:

C0	output	D/A bit 0
C1	output	D/A bit 1
C2	output	D/A bit 2
C3	output	D/A bit 3, or selects input switches S201, S202
C4	output	D/A bit 4, or selects LSD of low limit
C5	output	D/A bit 5, or selects MSD of low limit
C6	output	D/A bit 6, or selects LSD of high limit
C7	output	D/A bit 7, or selects MSD of high limit

Port D:

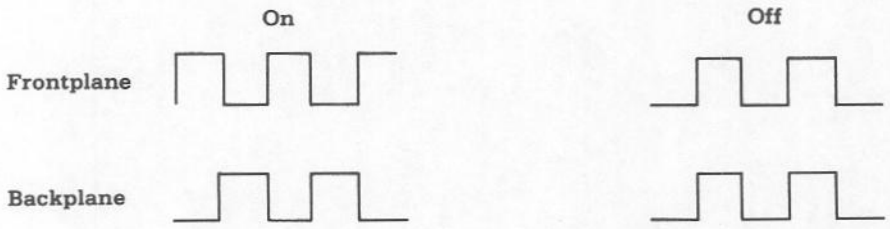
D0	output	Clock for display shift register
D1	output	Data to display shift register
D2	output	Switch for comparators; 0 is on, 1 is off
D3	output	Strobe, latches data into shift register outputs
D4	output	Switch for backlight; 0 is off, 1 is on
	input	External supply sense
D5	output	Red LED; 1 is on, 0 is off
D6	output	Oscillator on/off control; 0 is off, 1 is on
D7	output	Tone; 0 is 2 kHz, 1 is 1 kHz

Figure 7. Input/Output Ports.

2.3 LCD Display

The oxygen monitor uses a custom Liquid Crystal Display (LCD) that indicates oxygen (O2) concentration as a number between 00 and 100 (%), and four status messages; BATT OK, LOW BATT, HIGH O2, and LOW O2.

The display is driven with a 5-volt square wave at a frequency of 100 Hz. A segment is turned on when the voltage applied to the frontplane is out of phase with the backplane voltage. A segment is turned off by having the frontplane voltage in phase with the backplane voltage. A square wave is used so the average voltage applied across the LCD is 0 volts. Any voltage component other than zero will cause the internal chemicals to plate the inside of the display and eventually cause the display to fail.



A 24-bit shift register with output latches is used to drive the display. Data is shifted into the register every 10 milliseconds (100 Hz) and stored in the output latches.

Components U201, U202 and U203 are CMOS shift registers. The enable pin of the shift registers is normally held "high". If the watchdog timer circuit (refer to section 2.9) senses a malfunction, it pulls the enable pins "low" to blank the display.

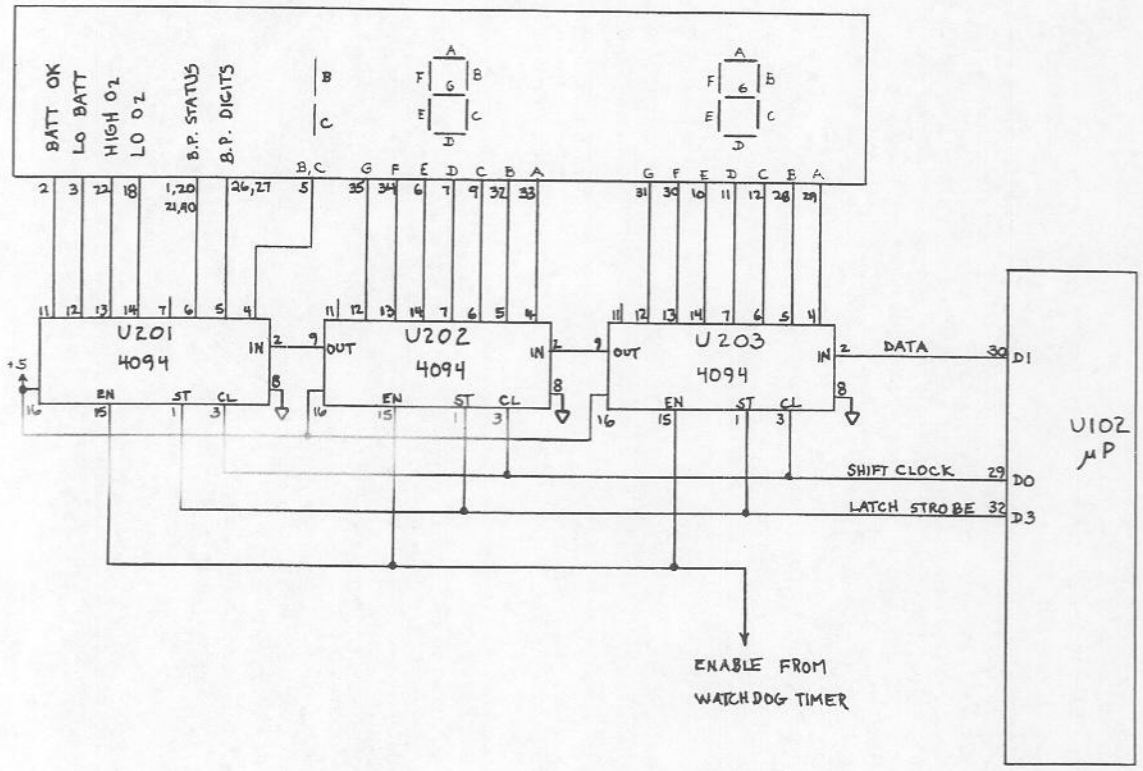


Figure 8. LCD Display

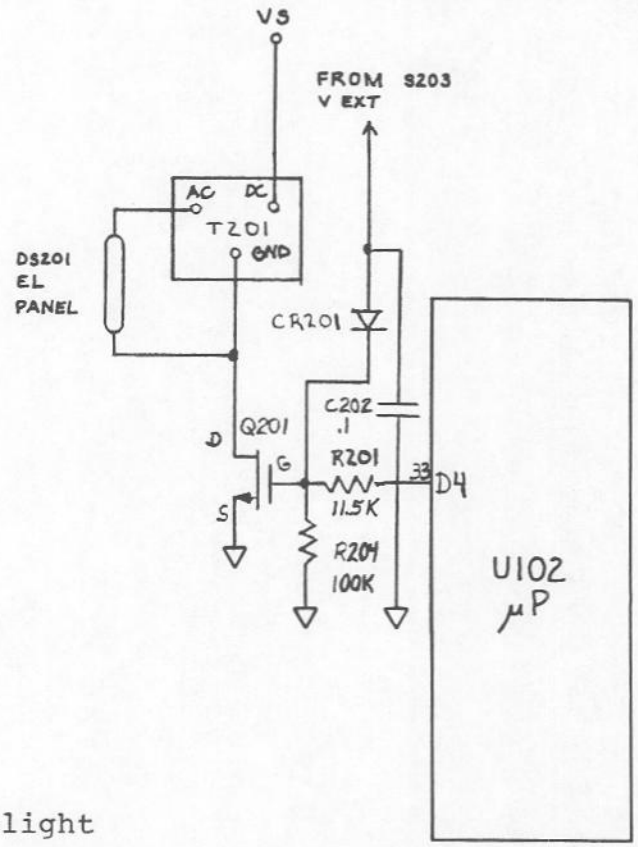


Figure 9. Backlight

2.4 Backlight

The LCD display is backlit by an electroluminescent (EL) panel (DS201) to improve visibility in low ambient light. The EL panel is driven by a DC-AC inverter (T201) The inverter is controlled by port D4 of the microprocessor through transistor Q201.

The inverter produces about 80 Vrms at 400 Hz from the switched battery supply (VS). Power for the inverter comes directly from the battery to reduce the current load on the power supply.

If the monitor is externally powered (installed in a Modulus II Anesthesia System), the external voltage at CR201 forces Q201 on causing the EL panel to be on, continuously.

Port D4 of the microprocessor also functions periodically as an external supply sense input. If an external supply is detected, the BATT OK message will not be displayed during a battery test.

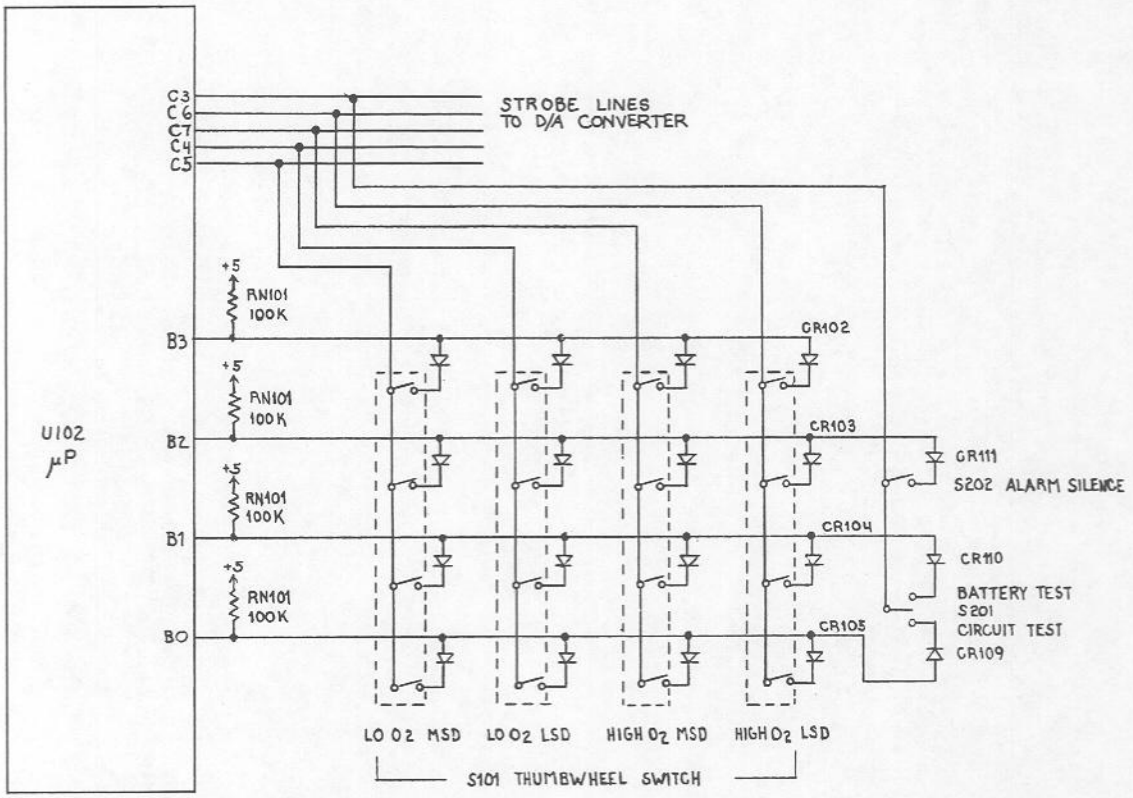


Figure 10. Front Panel Switches

2.5 Front Panel Switches

Operator inputs to the oxygen monitor consist of two limit switches (for High O2 and Low O2 alarm), two test switches (Batt Test and Circuit Test) and an alarm silence switch. The two limit switches are BCD-encoded thumbwheel switches, each having 8 output connections. The two test switches and alarm silence switch are momentary pushbutton switches.

The switches are connected in a matrix and scanned (strobed) by the microprocessor output lines (C3 to C7). The microprocessor selects one row of switches and inputs their status (B0 to B3). The diodes are used to eliminate false readings when more than one switch is closed.

Note that the output lines (C3 to C7) are shared between the switches and the Digital-to-Analog converter. This works because only one function is activated at a time, either the switches are being scanned or the digitial/analog converter is being used.

2.6 Sensor Input Circuit

The sensor produces a current (J104-4 / J104-3) which is proportional to the oxygen concentration at its detecting surface. This current is converted to a voltage by a resistor network consisting of R140 and R126. This voltage is about 46 millivolts for 100% oxygen.

The output current from the sensor decreases with age, thereby reducing the developed voltage. External control R140 (CAL pot) is used by the operator to compensate for the reduced output.

The sensor also contains a thermistor to compensate the circuit for temperature variations (J104-5). The resistor R122 is part of this circuit.

The resistor divider network feeds into an amplifier with a gain of 27. When the sensor is outputting 46 mV (the approximate value for 100% oxygen when the sensor is new)) the divider network is set at 80%. With the fixed gain of 27, the output from the amplifier is 1 volt.

The sensor contains two cells. To prevent oxide build-up, the unused cell (J104-6) is connected to load resistor R144.

The sensor input circuit includes analog switches (U109) which allow the system to measure the offset of the amplifier (Pins 3, 4, and 5) as described further in section 2.7 or to connect a fixed voltage reference (Pins 6, 8, and 9) instead of the sensor (Pins 1, 2, and 13) for the Circuit Test mode.

A positive offset voltage is injected into the amplifier via R131 to ensure that the offset will be positive and thus can always be measured.

Components R112, CR117 and CR118 provide electrostatic discharge protection of the sensor input.

The circuit consisting of U110, R127, R128, and R139 are not used with the present sensor (Stock Number 0237-2034-700).

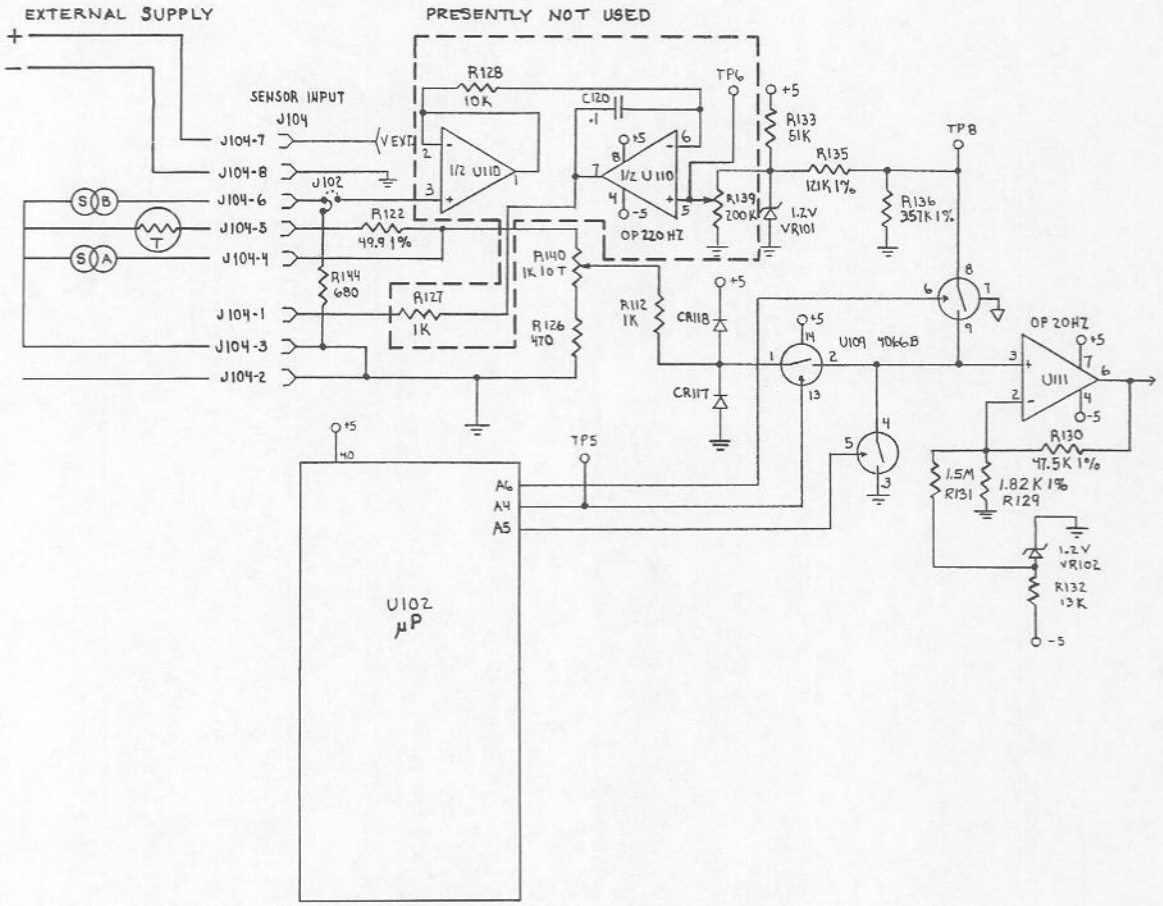


Figure 11. Sensor Input Circuit

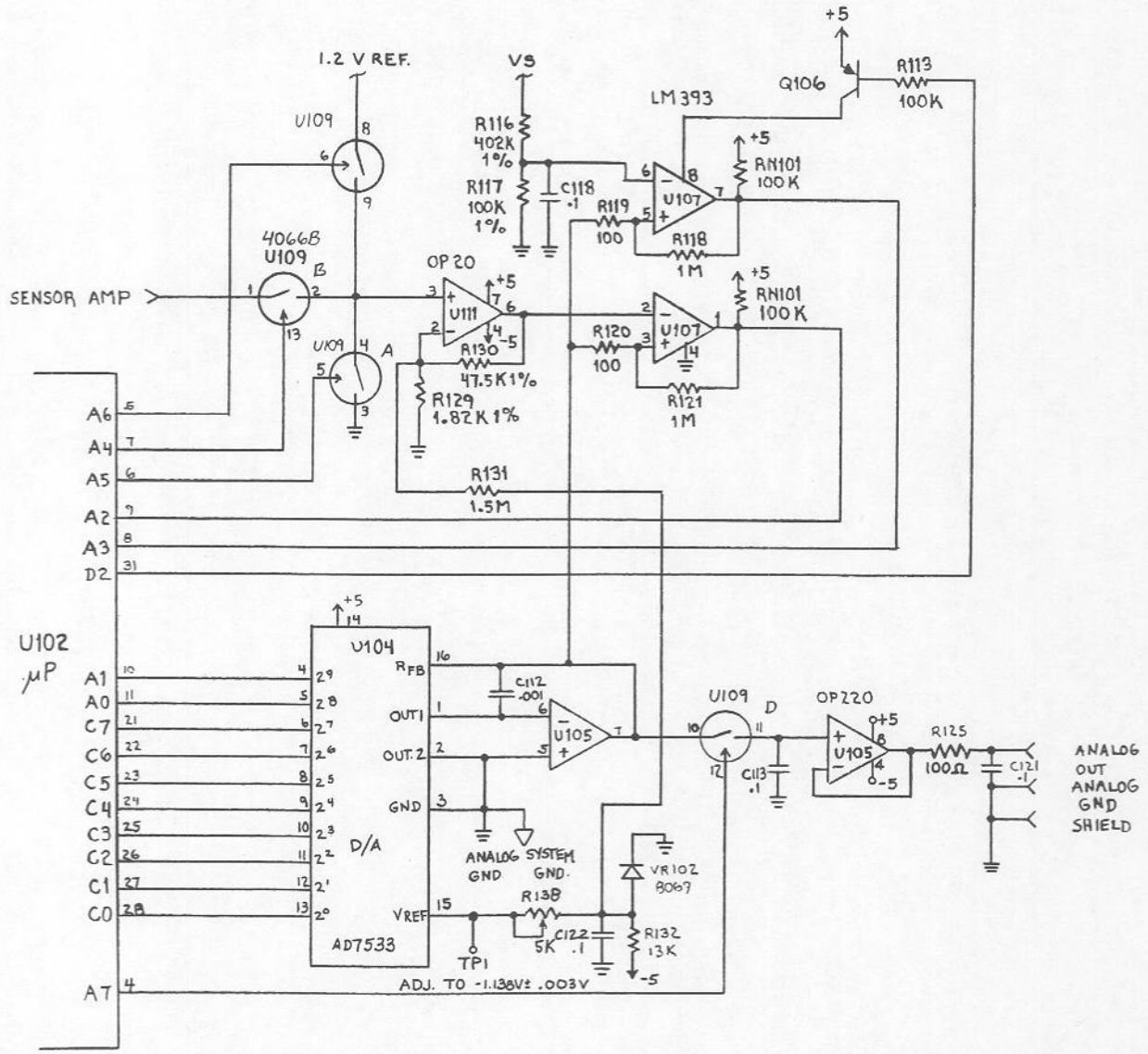


Figure 12. Digital-to-Analog Converter

2.7 D/A - A/D Converter

The digital-to-analog converter (U104 and its associated circuitry) performs two functions: it generates the analog output voltage as described in section 2.11 and is part of the analog-to-digital converter as described here.

Integrated Circuit U104 is a 10-bit CMOS D/A converter that produces a current which is proportional to the digital value present at its input terminals. The output current of the D/A unit is converted to a voltage by amplifier U105. The output voltage range is from 0 to 1.138 volts.

The reference voltage (U104-15) is generated by a fixed voltage reference diode (VR102) and an adjustment resistor (R138). The reference voltage (Vref) is set to -1.138 volts (section 3.3).

The output of the D/A converter (U105-7) is connected to two voltage comparators (U107). One comparator measures the voltage from the sensor amplifier and the other comparator measures battery voltage. The outputs from each comparator are connected to inputs on the microprocessor (U102).

The microprocessor uses a "successive approximation conversion routine" to convert the battery voltage or the sensor amplifier voltage to a 10-bit digital number.

Resistors R118 and R121 provide a slight hysteresis to the comparator outputs to help eliminate oscillations.

To minimize power drain on the batteries the comparators are only powered when the conversion routine is in effect. Transistor Q106 is turned on when the analog to digital software routine is executed, and turned off when completed.

Auto-Zero Logic

The "auto-zero logic" is a software routine that measures the offset voltage of the sensor amplifier (U111) and subtracts it from the sensor voltage. The microprocessor grounds the input of the amplifier (using U109, switch A) and measures the offset voltage, connects the sensor output to the amplifier (using U109, switch B) and measures the output, and finally, subtracts the offset from the output voltage to determine the sensor voltage. A negative offset voltage is injected into the inverting input of the amplifier via R131 to ensure that the offset is always positive.

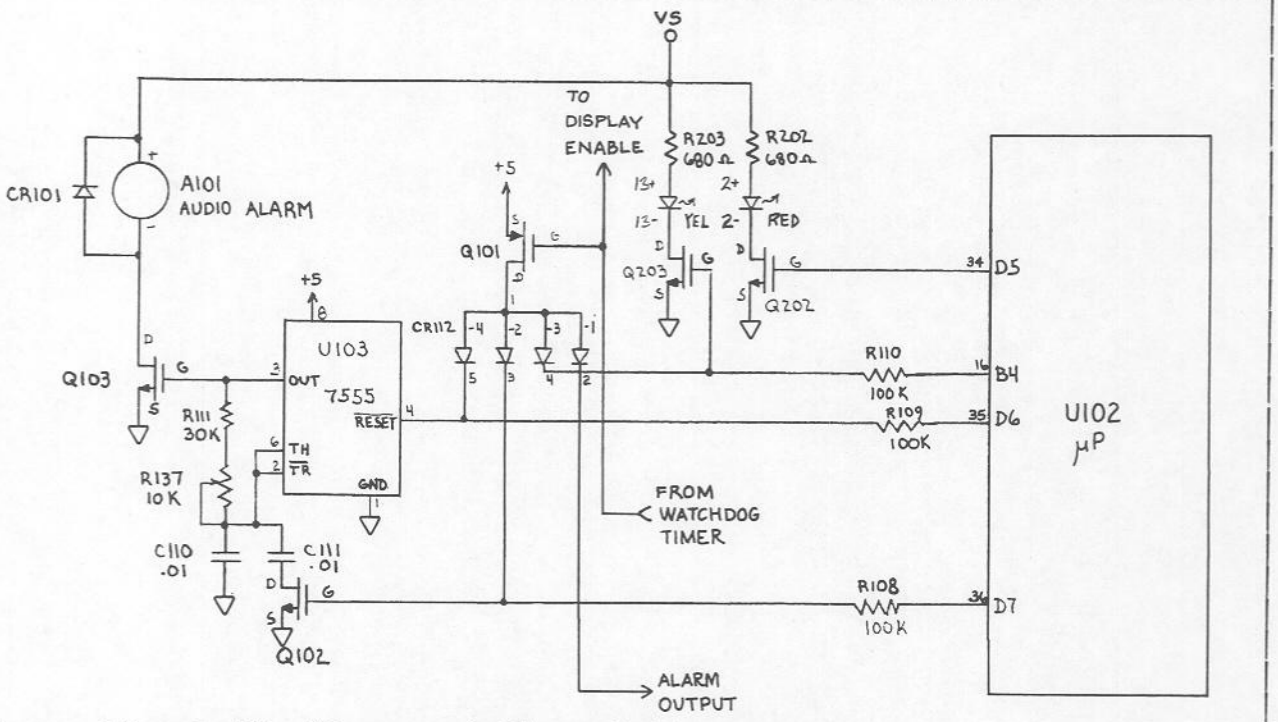


Figure 13. Audio Alarm and Alarm Indicators

2.8 Audio Alarm and Alarm Indicators

Audio Alarm:

The monitor's audible alarm consists of an audio transducer (A101) and an oscillator (U103) that can generate a tone of either 1 kHz or 2 kHz. The oscillator is a CMOS version of the 555 timer. The lower frequency of the oscillator is set by the RC time constant of resistors R111 and R137 and capacitors C110 and C111 (through Q102). The frequency is doubled by disconnecting capacitor C111 (Q102 open). Variable resistor R137 is used to tune the lower frequency to 1 kHz.

The transducer is driven by FET Q103 from the output of the oscillator. Diode CR101 across the transducer eliminates the voltage spike generated by the inductive load of the transducer when it is turned off.

LED Alarm Indicators:

The red and yellow LEDs are located on the alarm silence switch. The red LED is driven by Q202 via port D5 of the microprocessor. The yellow LED is driven by Q203 via port B4 of the microprocessor or the watchdog timer in case of a microprocessor failure. Power for the LEDs comes directly from the battery to reduce the current load on the power supply.

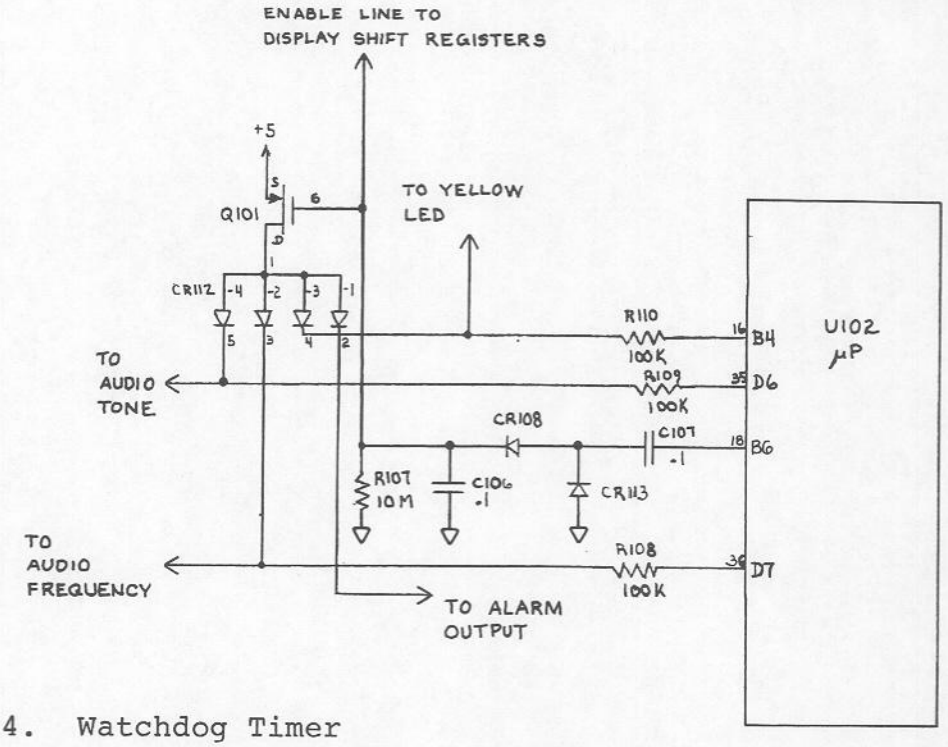


Figure 14. Watchdog Timer

2.9 Watchdog Timer

The watchdog timer circuit is used to detect when the processor stops running due to some error. The processor, when operating correctly, outputs a square wave of about 50 Hz on port B6. This square wave is capacitively coupled (C107) to a diode rectifier circuit (CR108/CR113) which charges the load capacitor (C106) to about 5 volts. The voltage keeps Q101 turned off and the display enable lines high.

If the processor stops operating for some reason, the load resistor (R107) will discharge capacitor C106 turning Q101 on and pulling the display enable lines low to blank the display. When turned on, Q101 activates the associated alarms through isolation diode pack CR112.

CR112-1 pulls the remote Alarm Output line low (see section 2.10).
CR112-3 turns on the yellow LED alarm indicator (see section 2.8).
CR112-2 selects the low (1 kHz) audio tone (see section 2.8).
CR112-4 turns on the audio alarm.

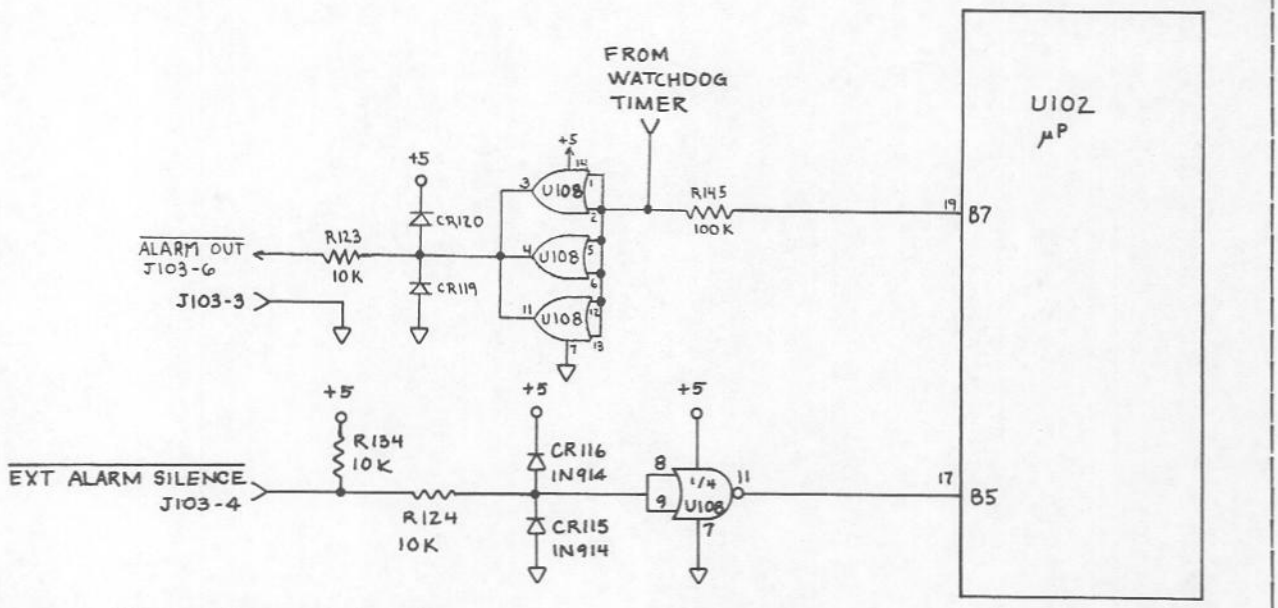


Figure 15. Alarm Output

2.10 Alarm Output

When an alarm condition is detected by the microprocessor, or by the watchdog timer, the ALARM OUTPUT line is pulled low. U108 provides about 1 mA of drive current, while CR119, CR120, and R123 provide static discharge protection.

Refer to Figure 16, Figure 17, and Figure 18.

When no alarm condition exists, ALARM OUTPUT is high (> 4.5 volts). When an alarm condition occurs, ALARM OUTPUT emits a series of 10 ms pulses corresponding to the alarm condition which exists. Alarm conditions are prioritized so that only the highest priority code is sent. When pulses are not being transmitted, ALARM OUTPUT remains logic low. This allows a simple alarm indicator to be connected to ALARM OUTPUT when individual alarm decoding is not necessary.

External Alarm Silence:

An input is provided for remote alarm silencing. A normally open switch connected between pin 4 and pin 3, when closed, will silence the audible alarm just as the "alarm silence" switch on the front of the monitor. The input is high-to-low sensitive, a continuous low input will not maintain an alarm silence. The input is a transient-protected CMOS input. A maximum input voltage of 5.5 volts and a minimum of -0.5 volts are allowed.

Number of Pulses	Alarm Condition	Priority
1	LOW O2	1
2	HIGH O2	2
3	"00" %O2 displayed	3
4	Discharged batteries	4
5	Low O2 limit < 18%	5
6	LOW BATT	6

Figure 16. Remote Alarm Pulse Code

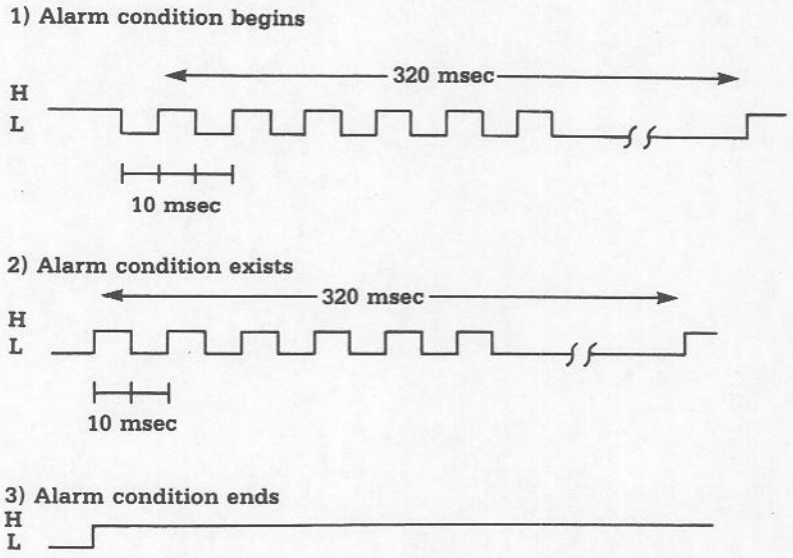


Figure 17. Alarm Output Waveforms

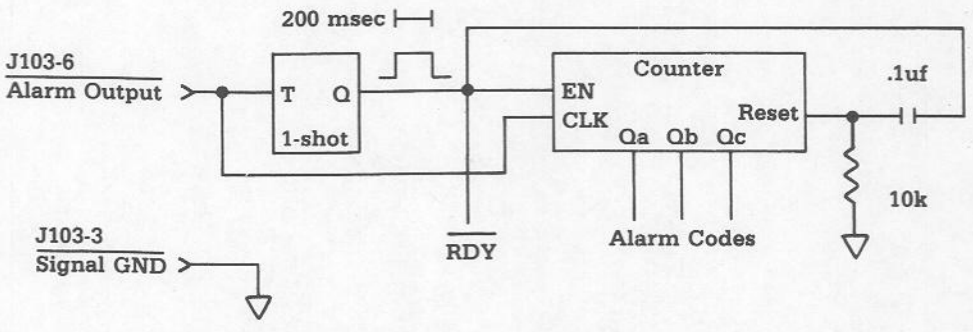


Figure 18. Alarm Interface Circuitry

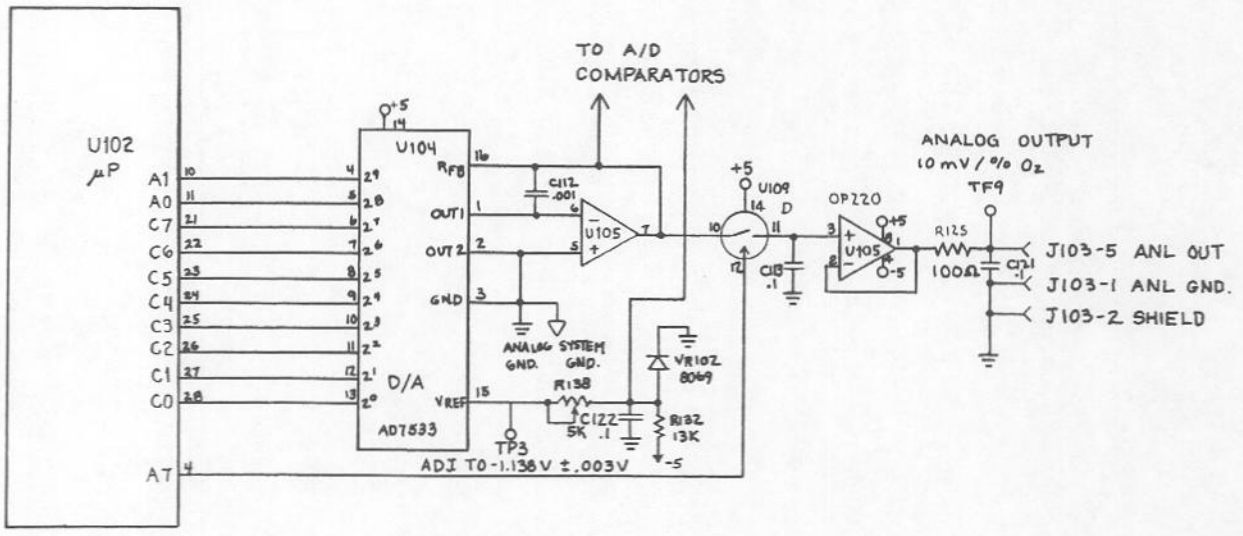


Figure 19. Analog Output

2.11 Analog Output

The analog output consists of a sample-and-hold analog register (U105) with the input voltage coming from the D/A converter (U104).

The microprocessor outputs a 10-bit digital value which the D/A converts to an analog voltage (see section 2.7). This voltage is connected to the sample-and-hold capacitor (C113) through the analog switch (U109, switch D). When the capacitor is charged to the new value, the switch is opened. The voltage across the capacitor is buffered by the high input impedance amplifier (U105) and available at the monitor's Output jack (J103). The sample-and-hold register is updated every 10 ms.

3.0 TEST AND CALIBRATION

The oxygen sensor is an expendable item whose output current for a specific concentration of oxygen decreases gradually with time. An external calibration control (CAL) is provided for the operator to compensate for the decrease in output (21% 02 calibration).

Additionally, as specified in the Operator's Manual, the monitor must be calibrated to "100% 02", at regular intervals, to verify the linearity of the oxygen sensor.

The monitor contains other controls which must be calibrated whenever the monitor is serviced or whose calibration should be checked whenever the monitor does not perform to specifications.

If the monitor cannot be calibrated or if it can be calibrated but does not function as specified, a malfunction is indicated which must be corrected before returning the monitor to clinical use.

CAUTION: This monitor contains electronic components that are susceptible to damage by electrostatic discharge. When disassembling the monitor, work at a static control workstation; wear a static control wrist strap to discharge accumulated static charges from you and any tool you are using. Handle the circuit boards by their nonconductive edges. Use an anti-static container for transport.

3.1 Special Tools Required for Calibration

Along with standard tools for electronic service and troubleshooting, the equipment listed in Figure 20 is required to check and calibrate the 5100 oxygen monitor.

The variable power supply is used to simulate the battery output (from fully charged cells to discharged cells) which the oxygen monitor must test and generate corresponding alarms and indicators.

1.	Static control workstation	3M Model 8005 (or equivalent) Ohmeda Stock No. 175-2311-000
2.	Digital Multimeter (DMM)	Beckman Model No. 3020 (or equivalent), 22 megohm input impedance, +/- .1% DC volts Ohmeda Stock No. 175-2273-000
3.	Variable DC Power Supply	0-5 volts, 0-100 ma
4.	Oscilloscope	B&K Model No. 1477, 15 MHz Dual Trace Scope (or equivalent) Ohmeda Stock No. 175-2302-000

Figure 20. Tools and Test Equipment

3.2 Functional Checkout Procedure

Inspect the monitor's housing and Output/Sensor jacks for damage.
Inspect the sensor cord and housing for damage.
Plug the sensor assembly into the Sensor input connector.
If applicable, turn the Modulus II System's master switch to Off.

Note: If during this procedure, the monitor indicates LOW BATT, replace the batteries with three, size C, alkaline batteries and repeat this procedure.

1. Set the Batt Power switch to On and verify the following.

   a. The red and yellow LEDs flash briefly.
   b. The audio tone sounds briefly.
   c. The BATT OK message and backlight appear for about 5 seconds.
   d. The display indicates a value for % O2.

2. Press and release the (☼)/Batt Test switch.
   Verify that the BATT OK message appears for about 5 seconds and that the backlight turns on.

3. Press and release the (☼)/Batt Test switch again.
   Verify that backlight turns off (BATT OK message appears for 5 sec.).

4. Press and hold the Circuit Test switch and verify the following.

   a. The audio tone sounds briefly.
   b. The four messages are displayed (BATT OK, LOW BATT, HIGH O2, LOW O2).
   c. The displayed digits are between 88 and 102.
   d. The red and yellow LEDs are lit.
   e. The display backlight is on.

While holding the Circuit Test switch pressed, press the alarm silence switch (🔕) to enter the System Test Mode.

Note: If the following tests are not completed in approximately 2 minutes, the monitor will automatically return to normal operation. If required, enter the System Test Mode again to complete the tests.

5. <u>Display Test</u>:

   The first test checks the individual segments of the LCD display. Verify that each segment of the digits, followed by the four messages, light in sequence.

   Note: For Software prior to Rev 3.0, the segments and messages should light individually in sequence.

Press the Alarm Silence switch to enter the next test.

6. Low O2 Alarm Limit Switch Test:

The displayed number (along with the LOW O2 message) should match the value selected by the Low O2 alarm limit thumbwheel switch.

Rotate both Low O2 thumbwheel switches through all 10 digits and verify that a matching number appears on the display. Verify that the monitor displays a 10 for any switch setting below 10.

Press the Alarm Silence switch to enter the next test.

7. High O2 Alarm Limit Switch Test:

The displayed number (along with the HIGH O2 message) should match the value selected by the High O2 alarm limit thumbwheel switch.

Rotate both High O2 thumbwheel switches through all 10 digits and verify that a matching number appears on the display.

Press the Alarm Silence switch to enter the next test.

7a. Input Offset Voltage Test:

Note: This test is only included in monitors using Software prior to Rev. 3.0.

Verify that the displayed value is between 08 and 70.

Note: Due to electrical noise in the analog ground circuit, changing of the Least Significant Digit is normal.

Press the Alarm Silence switch to enter the next test.

8. Battery Voltage test:

Verify that the backlight is on and that the displayed value is between 35 and 52.

The displayed number is 10 times the combined voltage of the three batteries in series. The backlight loads the batteries for testing. Fresh batteries should display approximately 45 (1.5 volts x 3 batteries x 10).

Press the Alarm Silence switch to exit the System Test Mode.

Alarm Function Tests

9. Set the Low O2 alarm limit to 18.
   Set the High O2 alarm limit to 25.
   If required, adjust the CAL control so that the displayed value is between 18 and 25.

   Verify that no alarms are active.

10. **Low O2 Alarm Test:**

    Adjust the CAL control so that the displayed value is less than 18 and verify the following.

    a. The oscillating two-tone sounds.
    b. The red alarm indicator (LED) flashes.
    a. The LOW O2 message appears on the display.

    Press the alarm silence switch and verify that the audio tone is silenced and that it resumes sounding after 30 seconds.

11. **High O2 Alarm Test:**

    Adjust the CAL control so that the displayed value is greater than 25 and verify the following.

    a. The intermittent low-tone sounds.
    b. The yellow alarm indicator (LED) flashes.
    a. The HIGH O2 message appears on the display.

    Press the alarm silence switch and verify that the audio tone is silenced and that it does not resume sounding after 30 seconds.

12. Adjust the CAL control so that the displayed value is 21 (calibrate to room air).

This completes the functional checkout procedure. If the monitor passed each of the tests, it is ready for calibration; refer to section 3.3.

3.3 Calibration

Do not calibrate the monitor unless it has passed the Functional Checkout Procedure (section 3.2).

CAUTION: This monitor contains electronic components that are susceptible to damage by electrostatic discharge. When disassembling the monitor, work at a static control workstation; wear a static control wrist strap to discharge accumulated static charges from you and any tool you are using. Handle the circuit boards by their nonconductive edges. Use an anti-static container for transport.

To prepare the monitor for calibration,

a. If applicable, remove the monitor from its mounted location and set it on a static control workstation.

b. Unplug the Sensor assembly.

c. Remove the back housing.

d. Replace the Sensor assembly.

Test and Calibration Procedure:

Refer to Figure 21.

1. Measure the voltage between TP4(+) and TP2(-).
   The voltage should be 5.25 +/- 0.25 volts.

2. Measure the voltage between TP10(+) and TP2(-).
   The voltage should be -5.25 +/- 0.25 volts.

3. Measure the voltage between TP3(+) and TP2(-).
   The voltage should be -1.138 +/- 0.004 volts.
   If required, adjust R138.

4. Measure the voltage between TP7(+) and TP2(-).
   The voltage should be +0.71 +/- 0.03 volts.
   If required, adjust R139.

5. Adjust the monitor's CAL control to display 20%.
   Measure the voltage between TP9(+) and TP2(-).
   The voltage should be +0.200 +/- 0.006 volts.

6. Adjust the monitor's CAL control to display 36%.
   The voltage between TP9 and TP2 should now be +0.360 +/- 0.006 volts.

   Note: If the monitor cannot be adjusted to 36% (normal for cartridges that have been in use for a long time), verify that the voltage (in millivolts) is equal to the displayed number, for example, 29% should read 0.290 +/- 006 volts.

7. Adjust the monitor's CAL control to display 21% (calibrate to room air).

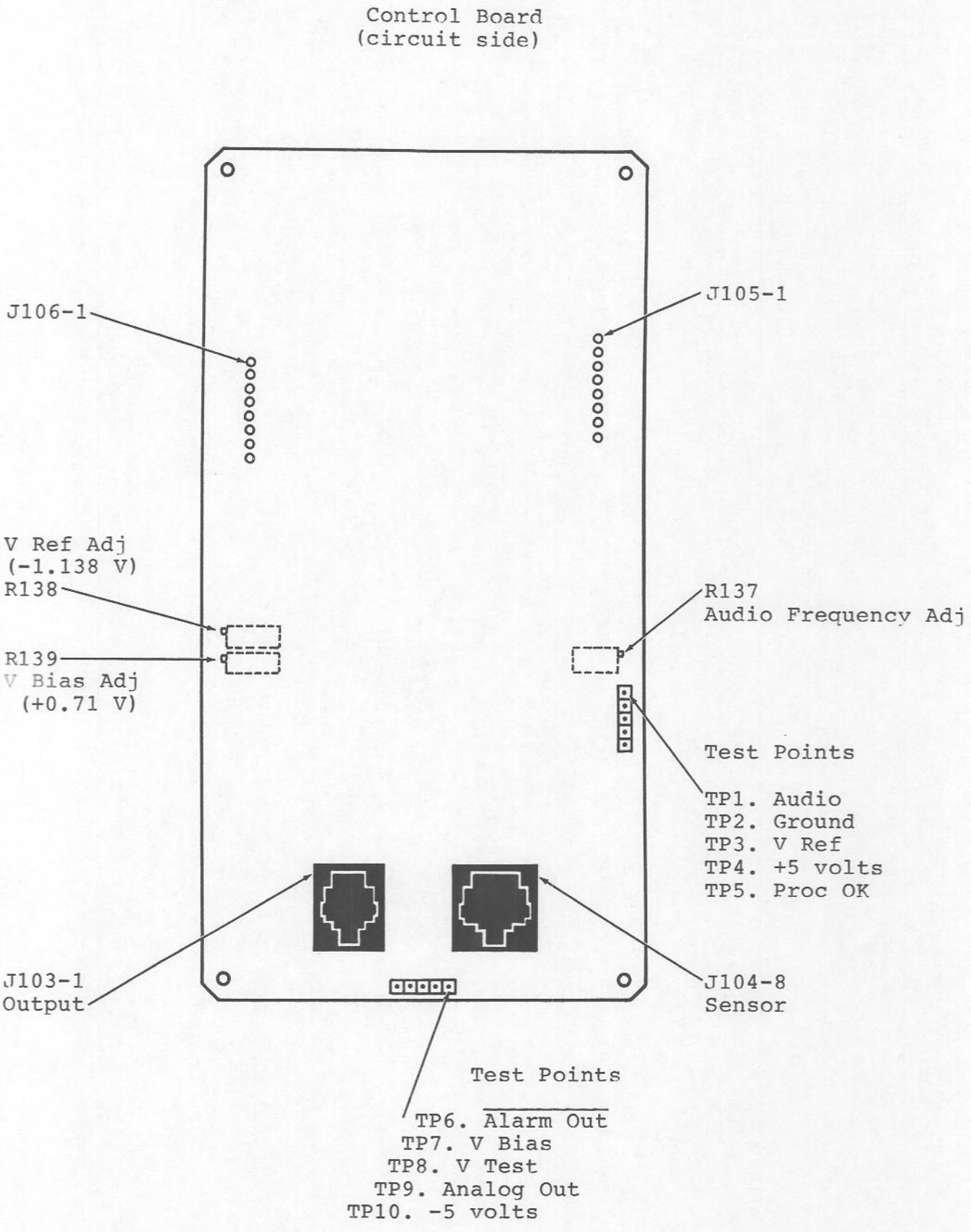


Figure 21. Test Points and Calibration Controls

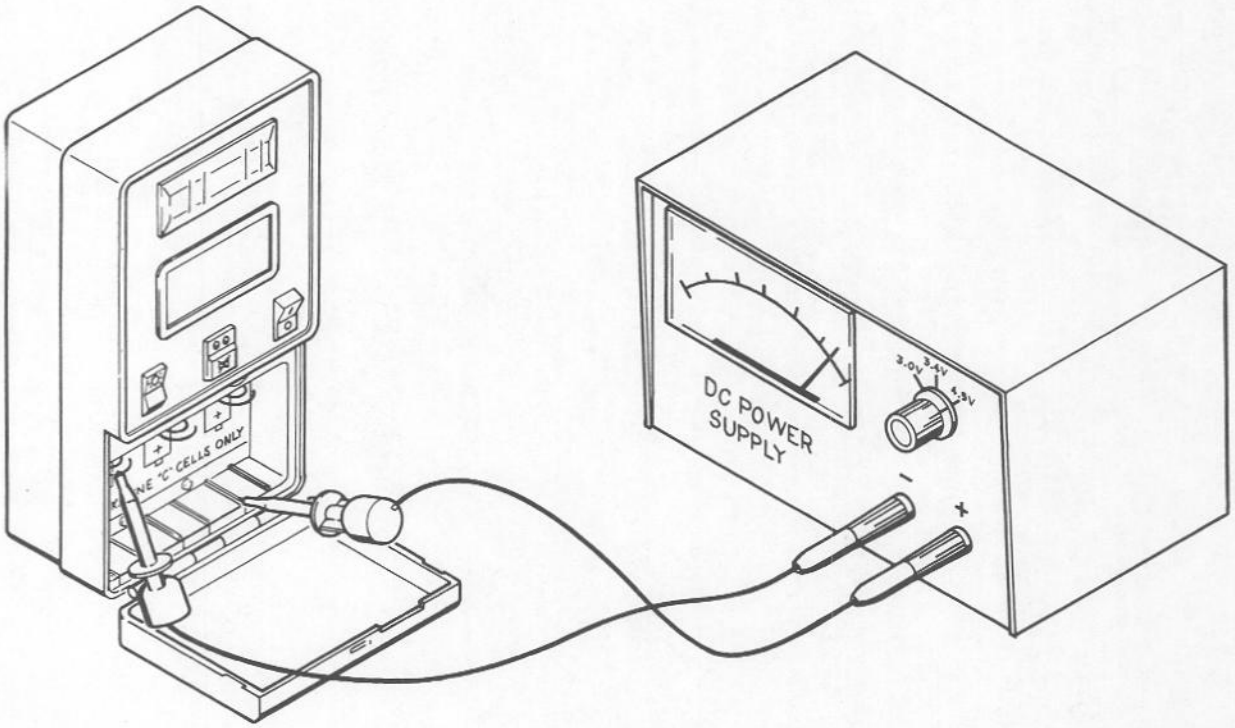


Figure 22. Battery Test Verification

Refer to Figure 22

8. Remove the batteries from the monitor.

9. Connect a power supply to the positive and negative battery terminals of the monitor and adjust the supply to 4.5 volts.

10. Slowly reduce the power supply voltage until the "Low Battery" alarm is activated.
    This should occur at +3.4 +/- 0.15 volts.
    A "Low Battery" alarm consists of the following.

    a. The low-tone beeps three times.
    b. The yellow alarm indicator (LED) is lit.
    c. The LOW BATT message is displayed.

11. Reduce the power supply voltage further until the "Discharged Batteries" alarm is activated.
    This should occur at +3.0 +/- 0.1 volts.
    The "Discharged Batteries" alarm consists of the following.

    a. The intermittent low-tone sounds.
    b. The yellow alarm indicator (LED) is flashing.
    c. The LOW BATT message is displayed.
    d. The numeric display is blank.

Adjustment of the Audio Tone Frequency

12. Set the power supply to 4.5 volts.
    Jumper J105-1 to ground (TP2).
    The low alarm tone should sound (1 kHz).
    Connect an oscilloscope between TP1 and ground.
    Verify that the frequency of the displayed waveform is 1000 +/- 50 Hz.
    If required, adjust R137.

This completes the monitor's calibration. Reassemble the monitor and perform the Final Test and Sensor Linearity Check (section 3.4).

3.4 Final Test and Sensor Linearity Check

After the monitor has been calibrated, verify the accuracy of the monitor's readings throughout its measurement range using a concentration of oxygen greater than 99% ("100%"). This test is required to verify the linearity of the oxygen sensor.

1. Set the High O2 alarm limit switch to "00" to disable the HIGH O2 alarm.
2. Turn the monitor On and allow it to stabilize for five minutes. (see note below).
3. Introduce the oxygen sensor into a "100%" concentration of oxygen and allow the display to stabilize (approximately two minutes).
4. Adjust the CAL Control until the display indicates 99% O2.
5. Remove the probe from the "100%" O2 and expose it to room air. The display must stabilize within three minutes and indicate 21% +/- 1 digit.

NOTE: If the display is not within the +/- 1% tolerance range the sensor cartridge is not linear and must be replaced (see note below).

6. To enable the HIGH O2 alarm, set the High O2 alarm limit to "30" (or to a desired High O2 alarm limit).

NOTE:

Before testing the monitor, turn the monitor on and allow the sensor to stabilize for at least five minutes. The five minute stabilization time assumes that the sensor (cartridge) assembly has been connected to the monitor for at least 24 hours immediately preceding this test. In cases where a new sensor cartridge has been installed, the five minute stabilization assumes that the cartridge was removed from its sealed protective packaging just before testing.

If the sensor assembly has been disconnected for more than five minutes or if the new sensor cartridge has been previously removed from its protective packaging, the monitor must be allowed to stabilize for as many hours as the sensor has been disconnected (or removed from its packaging), up to a maximum of 12 hours. The stabilization is required to remove an oxide layer that accumulates on the galvanic cell of the sensor (if disconnected and exposed to oxygen) impeding the output of the cell.

If in doubt, allow the monitor to stabilize for the presumed time of disconnect and perform this test. If the test is successful, the sensor can be assumed to be linear. However, if the test is not successful, allow additional time for the monitor to stabilize (up to 24 hours) and repeat the test.

4.0 TROUBLESHOOTING

Before servicing the monitor, one should thoroughly understand its normal operation.

-- Refer to the Operation and Maintenance Manual and to the previous chapters of this manual to learn how a properly operating monitor should function and to determine what the monitor is not doing correctly.

-- Refer to this chapter and the following chapters in this manual to help locate and correct the malfunction.

CAUTION: This monitor contains electronic components that are susceptible to damage by electrostatic discharge. When disassembling the monitor, work at a static control workstation; wear a static control wrist strap to discharge accumulated static charges from you and any tool you are using. Handle the circuit boards by their nonconductive edges. Use an anti-static container for transport.

4.1 Troubleshooting Procedure:

Let the symptoms be your guide. If only a single function is not working, concentrate on the circuit that controls that function (see section 2.0, Theory of Operation). If several symptoms are present, locate a circuit that is common to those functions. If a malfunction cannot be logically assigned to a specific circuit, the malfunction is most likely in the power supply circuits or in the microprocessor circuits.

Before disassembling the monitor, refer to the troubleshooting guide in the Operation and Maintenance manual for this product. Perform the "Circuit Test" and verify that the malfunction is not caused by any of the possible causes listed there.

1. Remove the back housing as shown in section 5.1.

2. Verify the plus and minus 5 volt power supplies as detailed in steps 1 and 2 of the calibration procedure (section 3.3).

3. If these voltages are missing or cannot be adjusted to specifications, replace the Control board or locate the specific cause of the malfunction using the following as your guide.

   - Theory of Operation (section 2.1, Power Supply Circuits)

   - Control Board schematic in Figure 31 (section 6.0).

Notes

5.0 REPAIR PROCEDURES

This section contains procedures for replacing the major components of the 5120 Oxygen Monitor. Items not covered can be replaced by observing common service techniques.

CAUTION: This monitor contains electronic components that are susceptible to damage by electrostatic discharge. When disassembling the monitor, work at a static control workstation; wear a static control wrist strap to discharge accumulated static charges from you and any tool you are using. Handle the circuit boards by their nonconductive edges. Use an anti-static container for transport.

5.1 How to Remove the Back Housing

Refer to Figure 23.

1. Place the monitor face down on a Static Control Workstation.

2. Remove the four screws (one in each corner) that hold the back housing in place.

3. While holding the front housing steady, gently rock the back housing from side to side until it comes loose.

To Replace the Back Housing

4. Lay the back housing over the monitor.
   Align the cutouts with the modular connectors.
   Applying pressure equally to all four corner, press the cover into place.

5. Secure the housing with four corner screws.

6. Test the monitor for proper operation (refer to section 3.2).

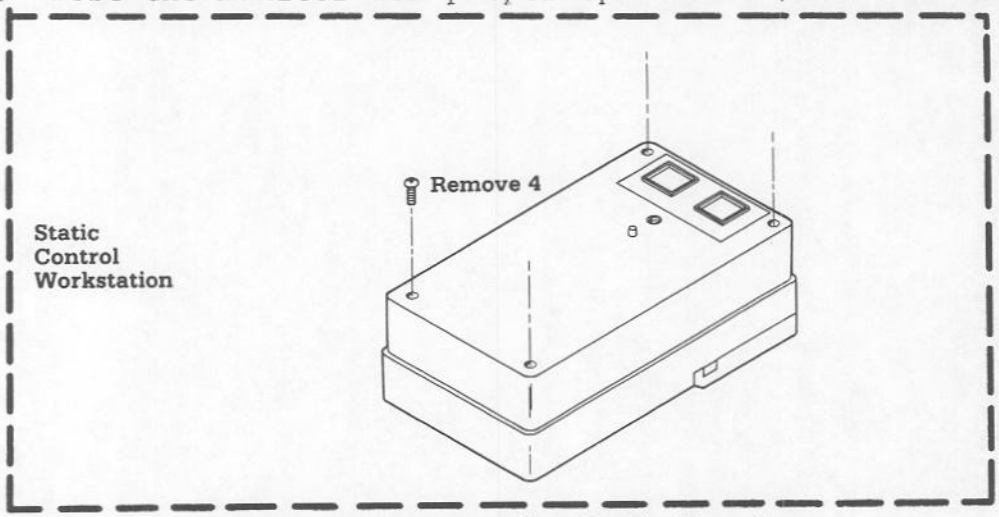


Figure 23. How to Remove the Back Housing

5.2 How to Replace the Control Board

Refer to Figure 24.

1. Remove the back housing (refer to section 5.1).

2. Remove the two hex nuts (split lockwasher) which hold the Control board to the front housing.

3. The Control board plugs into the Display board with two 8-pin single row connectors. To remove the Control board,

   a. Pull up on the lower end of the board (at modular connectors) until the circuit board clears the mounting screws.

   b. From the front of the monitor, push the alarm limit switch until it clears the housing.

   c. While holding both sides of the Control board in the area of the Display board connectors, alternately pull up on each side of the Control board until it comes loose from the Display board.

   NOTE: The knob for the calibration pot is not part of the circuit board assembly. Save it for use with the replacement circuit board.

To Replace the Control Board

4. Place the flat disc knob on the shaft of the CAL control (grooved surface facing out).

5. While holding the Control board with the component side up, position the monitor assembly over the Control board aligning the alarm limit switch and the calibration control into their respective cutouts.

6. Align the two connectors on each side of the Control board with the mating connectors on the Display board.

7. While holding both sides of the monitor assembly and the Control board aligned (in the area of the display) press the two components together until the connectors are fully mated.

8. Ensure that the alarm limit switch, the CAL control knob, and the mounting screws are in place.

9. Replace the mounting hardware (split lockwasher with hex nut). Replace the back housing.

10. Test the monitor for proper operation (refer to section 3.2).

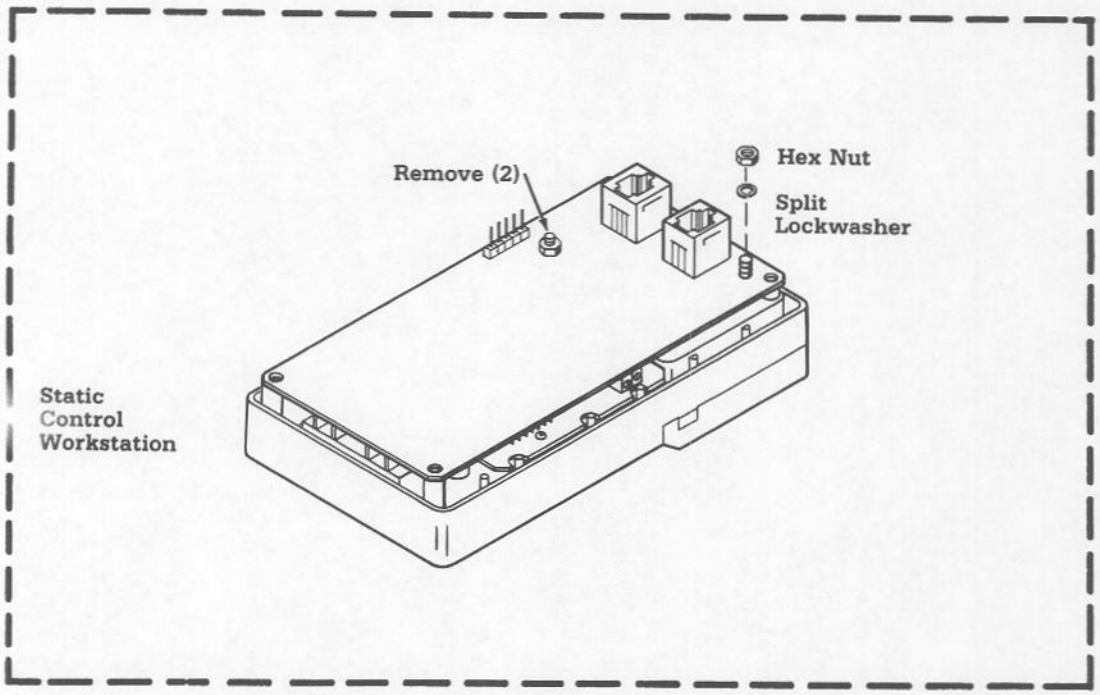


Figure 24. How to Replace the Control Board

5.3 How to Replace the Display Board

Refer to Figure 25.

1. Remove the back housing (refer to section 5.1).

2. Remove the Control Board (refer to section 5.2).

3. Remove the four screws that hold the Display board to the front housing.

4. Lift the Display board out of the front housing.

To Replace the Display Board

5. Ensure that the lens for the LCD display is in place in the front housing.

6. Position the Display board into the front housing making sure that the LCD display and the control switches fit properly into their respective cutouts.

7. Replace the Display board's mounting screws.
   Replace the Control Board.
   Replace the back housing.

8. Test the monitor for proper operation (refer to section 3.2).

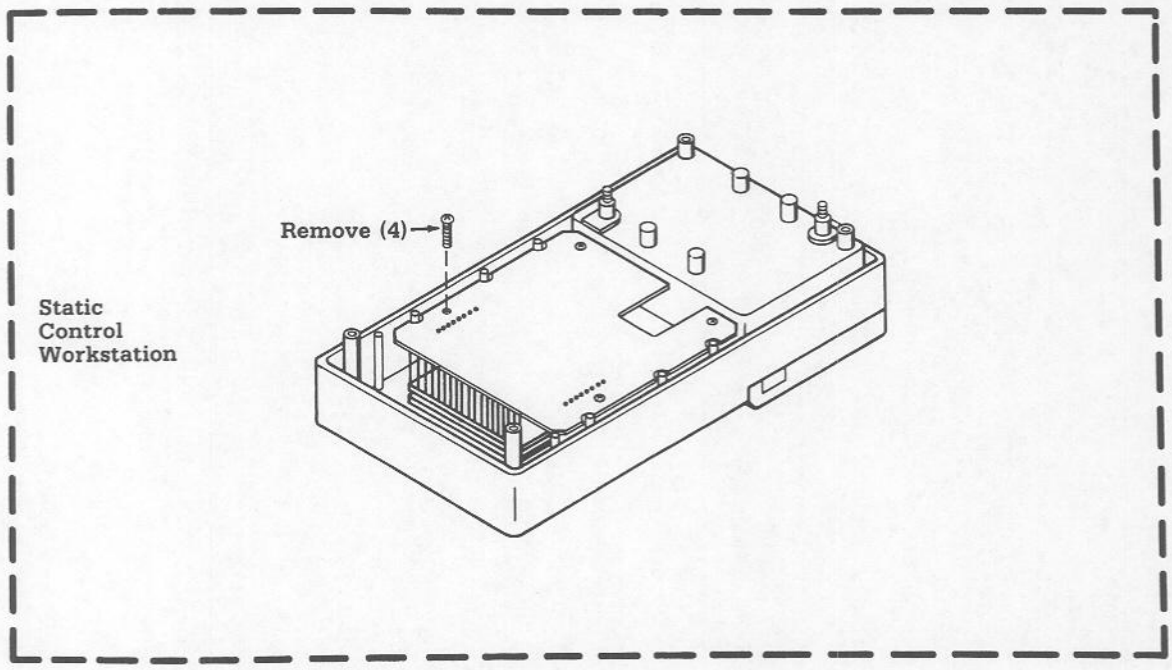


Figure 25. How to Replace the Display Board

5.4 How to replace Battery Terminals

Refer to Figure 26.

1. Open the front cover and remove the batteries.

2. Remove the back plate (with label) that holds the terminals in place (four screws).

3. The center terminals are now loose for replacement.

Note: The screws which hold the positive terminal (A) and the negative terminal (B) are also used to mount the Control board, therefore, to replace these terminals, further disassembly is required.

4. To replace the positive or negative end terminals,

   a. Remove the back housing (refer to section 5.1).

   b. Remove the two hex nuts (split lockwasher) which hold the Control board to the front housing.

   c. Replace the affected terminal making sure that the mounting screw is tight in the housing to ensure proper transfer of battery power to the Control board.

   d. Replace the Control board's mounting hardware (split lockwasher with hex nut). Replace the back housing.

4. Hook each center terminal over the lower edge of the front housing.

5. Place the back plate over the terminals with the label showing and properly oriented (positive terminals down).

6. Secure the plate making sure the terminals are properly seated in their front housing channels.

7. Replace the batteries.

8. Test the monitor for proper operation (refer to section 3.2).

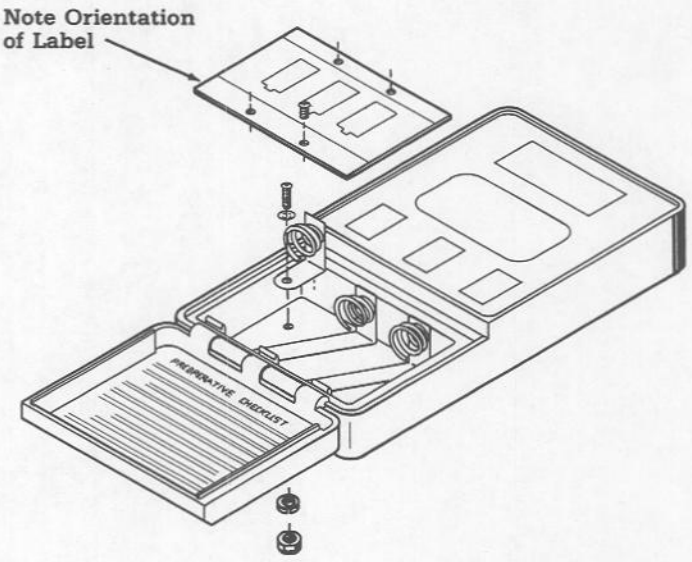
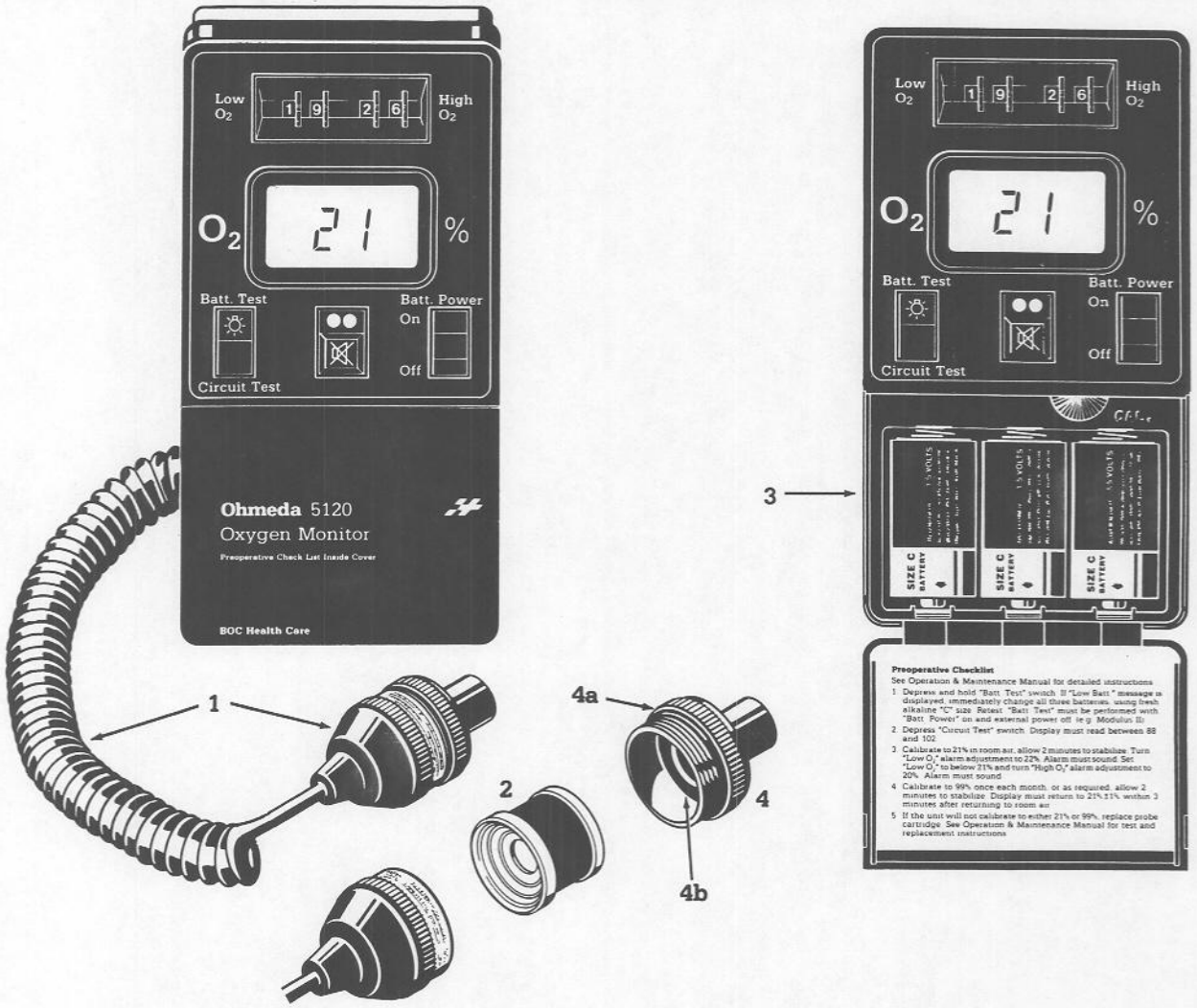


Figure 26. How to Replace the Control Board

Notes

6.0 PARTS LIST AND SCHEMATICS

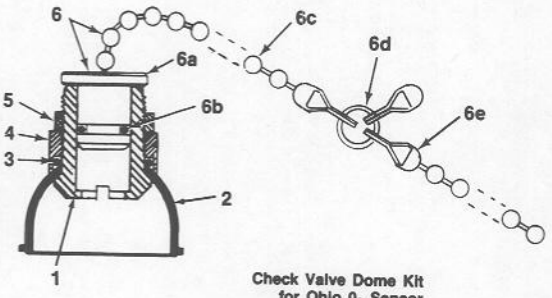
For External Components . . . . . see Figure 27
For Accessories . . . . . see Figure 28
For Monitor Assembly . . . . . see Figure 29
For Control Board . . . . . see Figure 30
For Display Board with socketed LCD display . . . . . see Figure 32
For Display Board with edge-connected LCD display . . . see Figure 34



Item	Description	Stock No.
1	Sensor Assembly (does not include Item 2)	0237-2030-700
2	Sensor Cartridge	0237-2034-700
3	Batteries (3), size C, alkaline	Obtain locally
4	Front Housing with O-rings	0237-2035-800
4a	O-ring (outside)	0210-0503-300
4b	O-ring (inside)	0210-0499-300

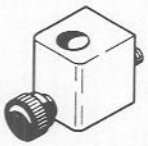
Figure 27. 5120 Oxygen Monitor

Item & Description	Stock No.
1. Socket, O_2 Sensor	0236-0015-535
2. Dome	0212-1062-200
3. O-Ring	0210-0704-300
4. Nut, Sealing	0402-1707-535
5. Nut, Jam	0402-1531-535
6. Chain & Plug	0236-0032-800
a. Plug	0236-0006-535
b. O-Ring	0210-0634-300
c. Chain only	0203-0060-500
d. Ring, split	0203-0103-300
e. Coupling, Chain/Bead	0203-0100-300

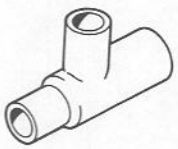


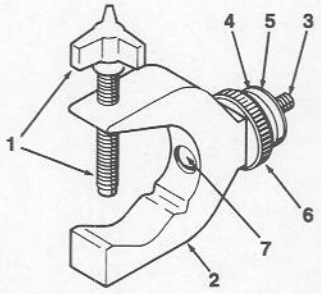
Check Valve Dome Kit
for Ohio 0_2 Sensor
Stock No. 0236-0035-800

Probe Holder
0237-2031-800



22 mm Tee Manifold
0212-0763-100

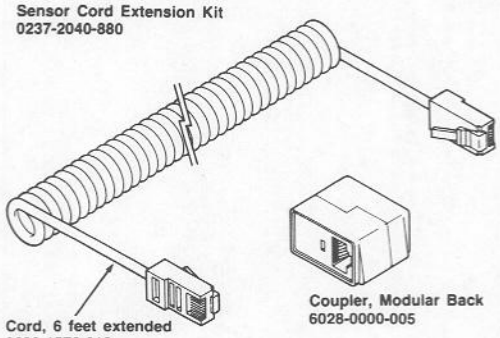




Mounting Clamp Assembly
237-2032-700

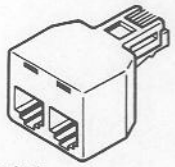
1. Knob with Stud Assembly	237-2033-700
2. Extrusion, Clamp	237-2000-100
3. Stud, Clamp - 1/4 - 20 × 1.43L	237-2008-500
4. Disk, Mounting	237-2011-500
5. Gasket	210-8064-300
6. Nut, Clamp 7/8 - 12 THD	237-2009-500
7. Knob, Ball 1/4 - 20 THD 0.75 OD	212-1951-300

Sensor Cord Extension Kit
0237-2040-880



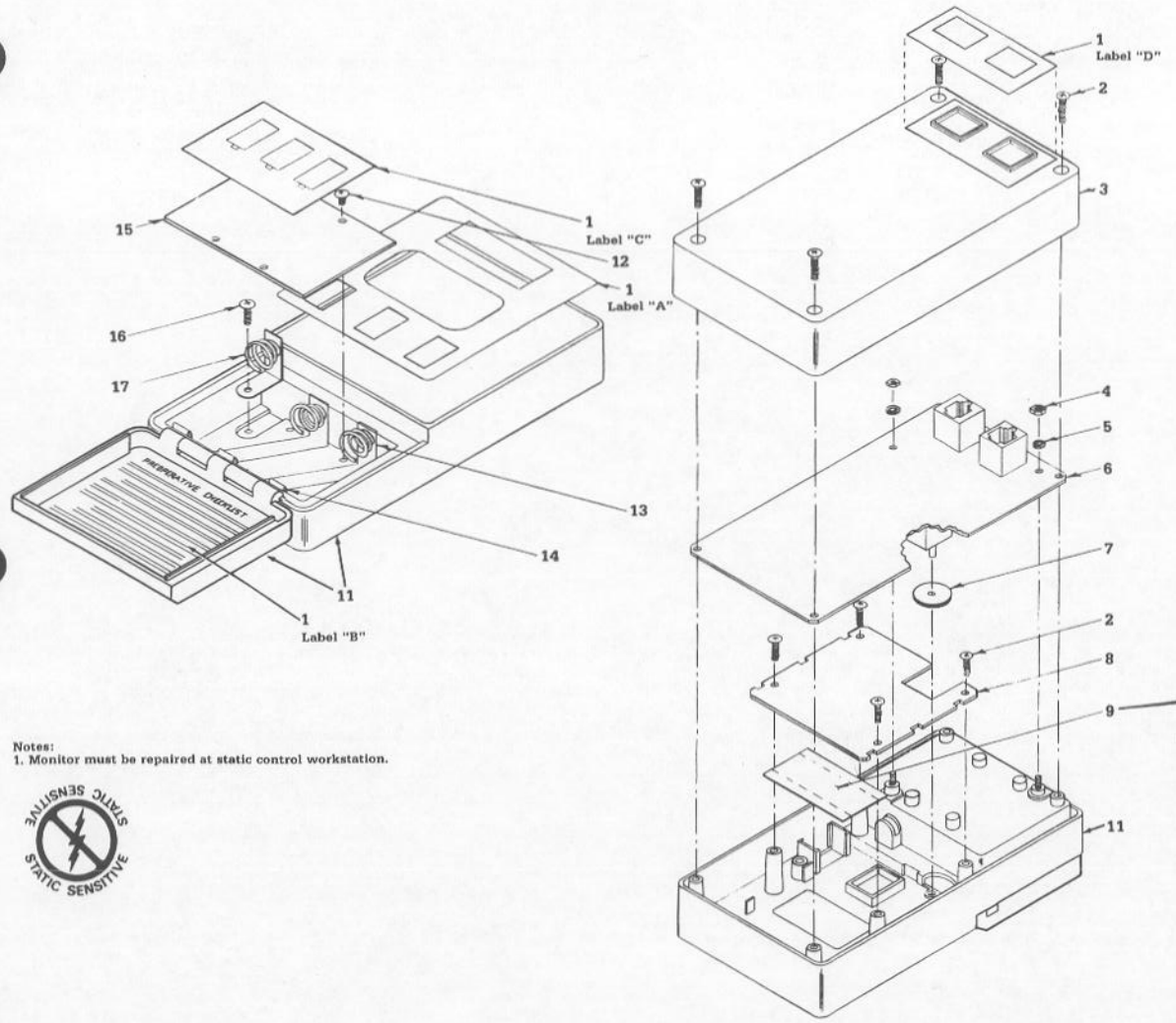
Cord, 6 feet extended
0690-1570-313

Coupler, Modular Back
6028-0000-005

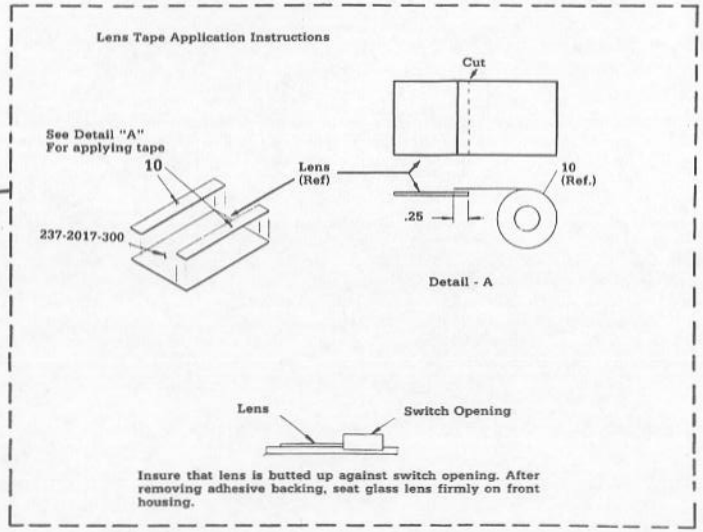


Duplex Jack
0690-1950-347

Figure 28. Accessories: Standard and Optional



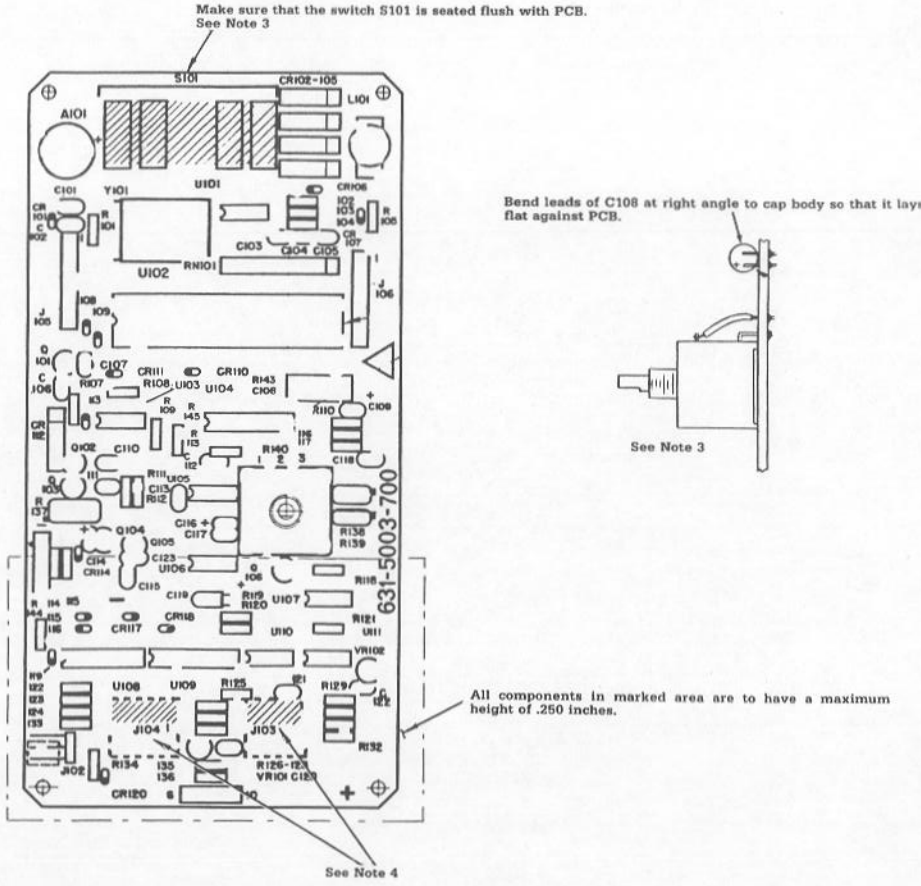
Item	Description	Stock Number	Qty
1	**Label Set (includes 4 labels)** – Label "A" - Front Panel – Label "B" - Preoperative Checklist – Label "C" - Battery – Label "D" - Output/Sensor	0205-4983-300	
2	Screw, #4-40 x 7/16, plastite	6019-0000-001	(8)
3	Housing, Rear	0212-0759-100	
4	Nut, Hex #4	0144-3117-113	(2)
5	Lockwasher, Split #4	0144-1104-331	(2)
6	Control Board, Replacement (see Figure 30 on page 6-4)	0631-5044-700	
7	Knob, Calibration	0212-0756-100	
8	Display Board, Replacement (see Figure 32 on page 6-6 or Figure 34 on page 6-8)	0631-5045-700	
9	Lens (requires tape, Item 10)	0237-2017-300	
10	Tape, Double Sided Roll, (5 mil x 2.0" W x 60 yd LG)	6016-0000-011	
11	Front Housing Assembly	0212-0772-300	
11a	- Housing, Front		
11b	- Pin, Hinge		
11c	- Cover, Door (without Label "B", Item 1)		
12	Screw, #4 x 1/4"	0142-4862-104	(4)
13	Terminal, Center	0237-2025-300	(2)
14	Terminal, Battery Positive	0234-4025-300	
15	Cover, Battery Terminal	0237-2004-300	
16	Screw, #4-40 x 1/2"	0140-6517-108	(2)
17	Terminal, Battery Negative.	0237-2026-300	



Notes:
1. Monitor must be repaired at static control workstation.

Figure 29. Monitor Assembly

Item	Description	Stock Number
----	Control Board, complete	0631-5044-700
A101	Audio Transducer, QMB-01	0690-1100-307
(*) C101,102	Capacitor, 22pf	6007-0000-001
C103	Capacitor, 33pf	0682-1122-303
C104,112	Capacitor, .001 mfd	0682-1150-305
C105-107,109, 113,115,117, 118,120-123	Capacitor, .1 mfd	6007-0000-031
C108	Capacitor, 330mfd, Elec	0682-7112-301
C110,111	Capacitor, .01mfd	0682-1170-315
C114	Capacitor, 1mfd, Tant	6007-0000-041
C116,119	Capacitor, 10mfd Tant	0682-2595-302
CR101,106, 108-111,113-120	Diode, 1N914B	6004-0000-057
CR102,103,104, 105,112	Diode Network, DAP401	0683-0200-301
CR107	Diode, Schottky 5082-2835	0683-0100-310
J102	Connector, Header, 8-pin, Rt Angle	0690-1563-357
For J102	Jumper, Header, 2-position	6032-0000-020
J103	Connector, Phone Jack, 6-pin	0690-1950-334
J104	Connector, Phone Jack, 8-pin	0690-1950-335
J105,106	Connector, Header, 8-pin	0690-1563-356
L101	Inductor, 5 MHz, Toroid	0690-1850-303
Q101	Transistor, MOSFET P-channel VPO 300L	0685-0120-300
Q102,103	Transistor, MOSFET N-channel VN_2222L	0685-0121-300
Q104	Transistor, NPN 2N3704	0685-0113-300
Q105,106	Transistor, PNP MPS6519	6004-0000-056
(*) R101,107	Resistor, 10M, 1/4W, 5%	0680-0595-300
R102,118,121	Resistor, 1M, 1/4W, 5%	6008-0005-106
R103	Resistor, 34.8K, 1/4W, 1%	0680-3915-334
R104	Resistor, 11.5K, 1/4W, 1%	0680-2250-308
R105,119,120,125	Resistor, 100 ohm, 1/4W, 5%	6008-0005-102
R108,109,110, 113,114,115,145	Resistor, 100K, 1/4W, 5%	6008-0005-105
R111	Resistor, 30K, 1/4W, 5%	6008-0005-304
R112,127	Resistor, 1K, 1/4W, 5%	6008-0005-103
R116	Resistor, 402K, 1/4W, 1%	6008-0003-585
R117	Resistor, 100K, 1/4W, 1%	6008-0003-005
R122	Resistor, 49.9 ohm, 1/4W, 1%	0680-3168-300
R123,124,128,134	Resistor, 10K, 1/4W, 5%	6008-0005-104
R126	Resistor, 470 ohm, 1/4W, 5%	6009-0005-472
R129	Resistor, 1.82K, 1/4W, 1%	0680-3915-332
R130	Resistor, 47.5K, 1/4W, 1%	0680-2250-309
R131	Resistor, 1.5M, 1/4W, 5%	6008-0005-156
R132	Resistor, 13K, 1/4W, 5%	6008-0005-134
R133	Resistor, 51K, 1/4W, 5%	6008-0005-514
R135	Resistor, 121K, 1/4W, 1%	0680-2250-307
R136	Resistor, 3.57K, 1/4W, 1%	0680-3915-333
R137	Resistor, Variable 10K, 20-turn	0681-0500-301
R138	Resistor, Variable 5K, 20-turn	0681-0190-300
R139	Resistor, Variable 200K, 20-turn	0681-1025-001
R140	Resistor, Variable 1K, 10-turn	0681-0104-300
For R140	Support Bracket	0237-2007-300
For R140	Tubing, 20GA Vinyl, .034" Lg (per ft)	0999-8262-010
(*) R143,146	Jumper	
R144	Resistor, 680 ohm, 1/4W, 5%	6008-0005-682
RN101	Resistor Network, 100K	0680-9000-314
S101	Switch Assembly, Thumbwheel - BCD	0690-2500-352
TP1-5,6-10	Connector, 5-pin Header, Test Points	0690-1563-355
U101	IC, Switching Regulator, RC4192	0684-0600-040
(*) U102	IC, Microprocessor MC1468705G2 (EPROM)	0228-4016-400
For U102	Socket, 40-pin DIP	6006-0000-056
U103	IC, Low Power Timer, 7555	0684-0400-011
U104	IC, 10-bit DAC, 7533 JN	0684-0400-041
For U104	Socket, 16-pin DIP	6006-0000-010
U105,110	IC, Dual Op-amp, OP220 HZ	0684-0600-017
U106	IC, Voltage Converter, 7660	0684-0400-036
U107	IC, Dual Comparator, LM393 P	0684-0600-024
U108	IC, 2-input NOR, 4001 B	0684-0187-300
U109	IC, Quad Switch, 4066 B	6004-0000-047
U111	IC, Low Power Op-amp, OP20 HZ	0684-0600-019
(*) Y101	Crystal, 1.8432 MHz	0686-0017-300
	(*)Substitute the following items for masked ROM Software (Prior to Rev)	
C101,102	Not Used	
R101	Resistor, 16K, 1/4W, 5%	6008-0000-351
R143,146	Resistor, 10K, 1/4W, 5%	0680-0497-300
U102	IC, Microprocessor MC146805G2PDS (ROM)	0228-4017-300
Y101	Not Used	


Make sure that the switch S101 is seated flush with PCB.
See Note 3
Bend leads of C108 at right angle to cap body so that it lays flat against PCB.
See Note 3
All components in marked area are to have a maximum height of .250 inches.
See Note 4
631-5003-700

1. This circuit board subject to damage by static electricity. Handle only at approved static control workstation.
2. Use an anti-static container for storage or transport.
3. R140 and S101 must be aligned to fit through front housing.
4. J103 and J104 must be aligned to fit through back housing.

Figure 30. Control Board Assembly

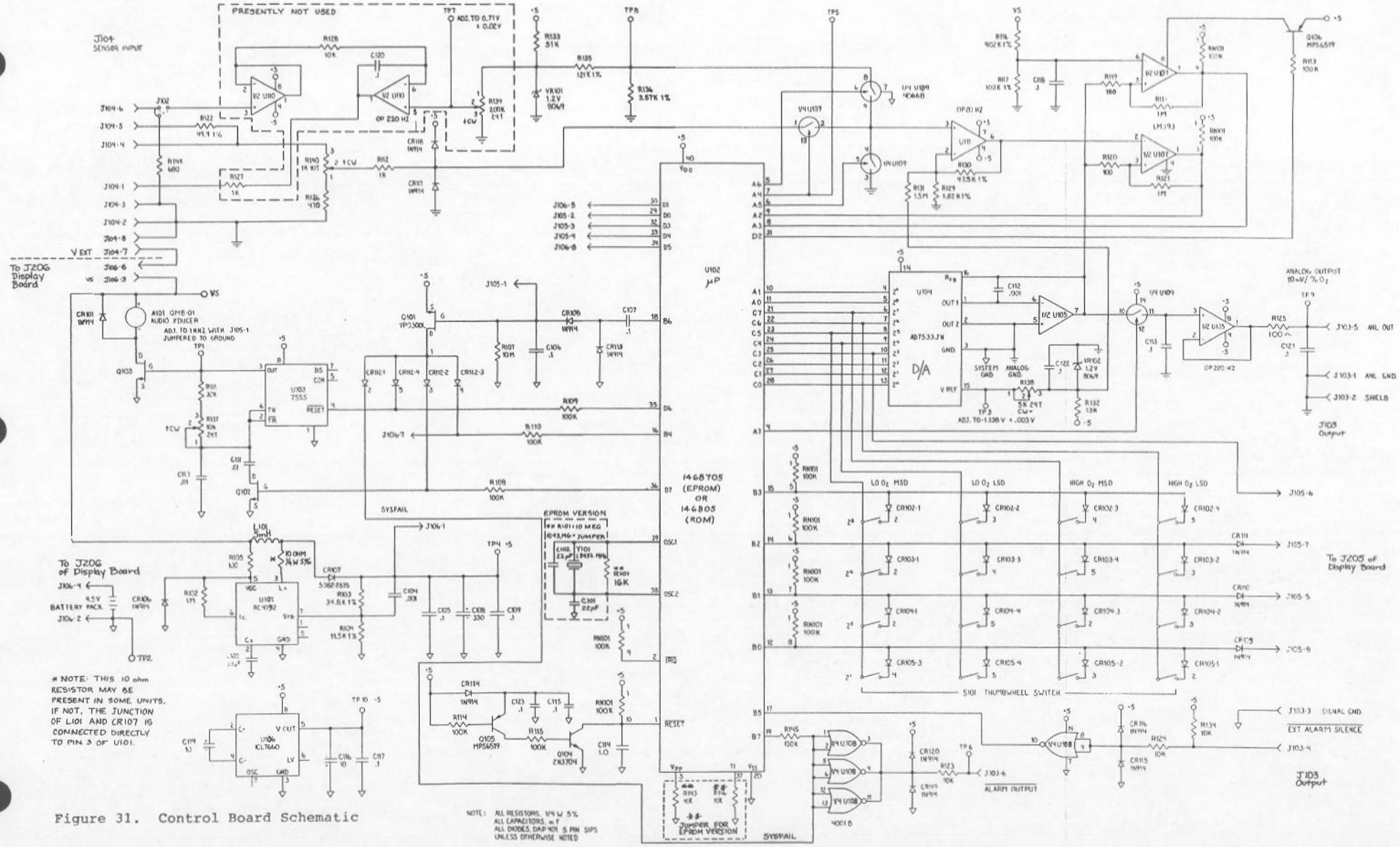
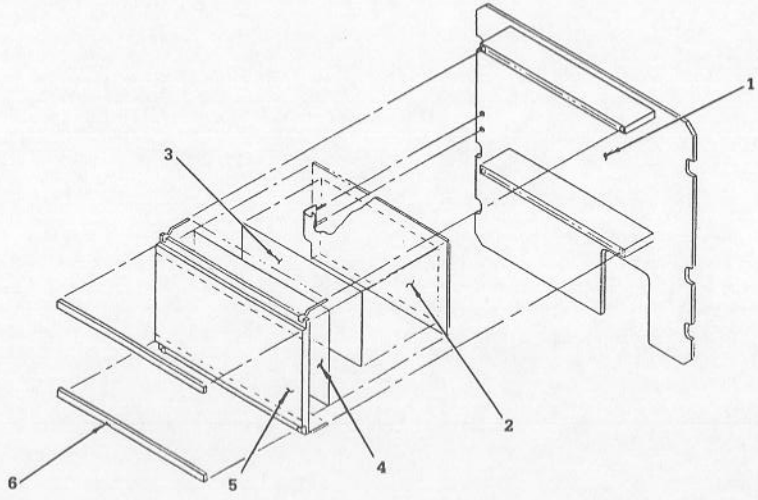
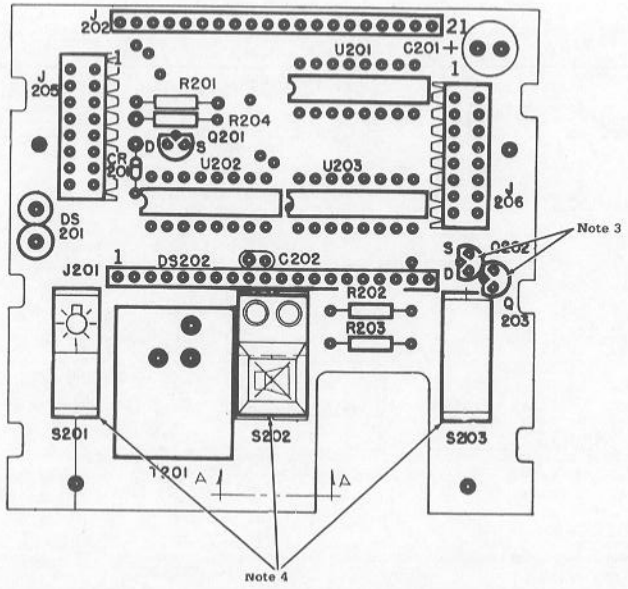
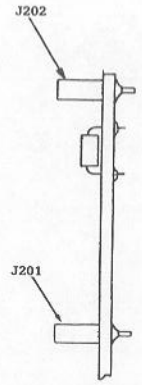


Figure 31. Control Board Schematic

Item	Description	Stock Number
....	Display Board, complete (includes LCD Display)	0631-5045-700
1	Display Board	
2 (DS201)	- Electroluminescent Panel, for DS202	0690-2100-319
3	- Filter, Yellow/Green	
4	- Tape, Double Sided Roll, (5 mil x 2.0" W x 60 yd LG)	6016-0000-011
5 (DS202)	- LCD Display, 40-pin (5120)	6017-0000-005
6	- Tape, Black Foam	0203-1987-300
C201	Capacitor, 330mfd	0682-7112-301
C202	Capacitor, .1mfd	6007-0000-031
CR201	Diode, 1N914B	6004-0000-057
J201,202	Socket Strip, 20-pin Elevated	6006-0000-066
J205,206	Connector, 8-pin, through board	0690-1561-457
Q201,202,203	Transistor, MOSFET N-channel VN2222L	0685-0121-300
R201	Resistor, 11.5K, 1/4W, 1%	0680-2250-308
R202,203	Resistor, 680 ohm, 1/4W, 5%	6008-0005-682
R204	Resistor, 100K, 1/4W, 5%	6008-0005-105
S201	Switch, Batt/Circuit Test	0690-2502-005
S202	Switch, Alarm Silence	0690-2502-007
For S202	Socket, 28-pin	6006-0000-043
For S202	Spacer, .069"	6032-0000-012
S203	Switch, Batt Power	0690-2502-006
T201	Inverter, DC-to-AC	0690-2454-312
U201,202,203	IC, Shift Register, 4094B	0684-0400-042

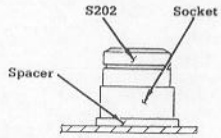






Notes:

1. This circuit board subject to damage by static electricity. Handle only at approved static control workstation.
2. Use an anti-static container for storage or transport.
3. Install Q202, Q203 with maximum height of .250 inches.
4. S201, S202, and S203 must be aligned to fit through front housing.



View A

Figure 32. Display Board Assembly (for socketed LCD display)

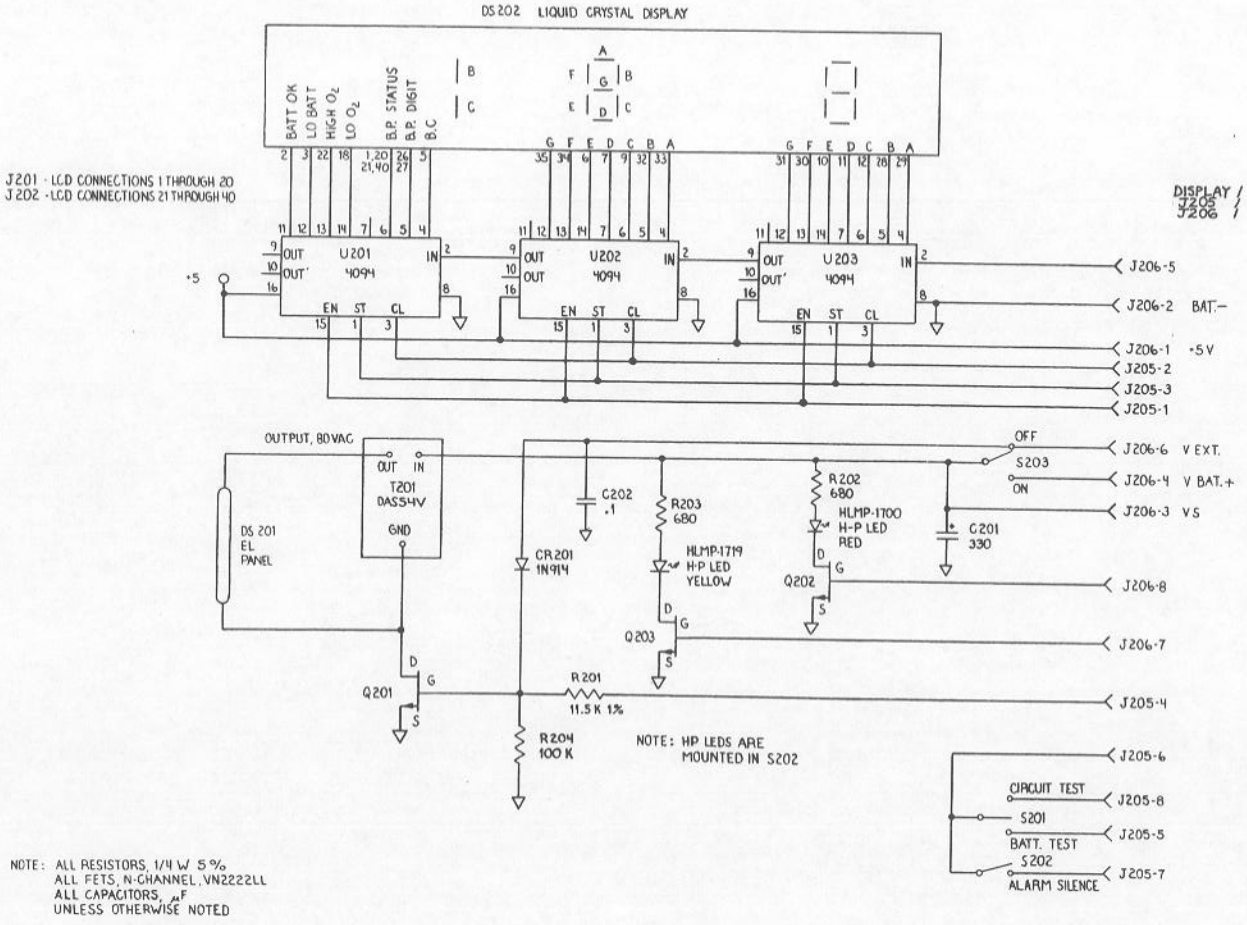
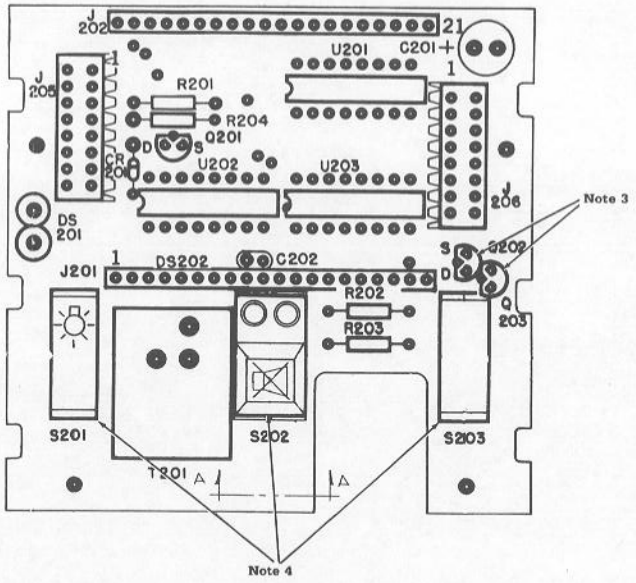
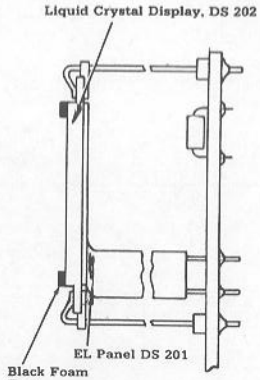


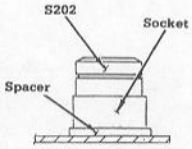
Figure 33. Display Board Schematic

Item	Description	Stock Number
----	Display Board, complete	see Figure 32
DS201	- Electroluminescent Panel, for DS202	0690-2100-319
DS202	- LCD Display	0690-2300-320
For DS202	- Tape, Black Foam	0203-1987-300
C201	Capacitor, 330mfd	0682-7112-301
C202	Capacitor, .1mfd	6007-0000-031
CR201	Diode, 1N914B	6004-0000-057
J201,202	Connector, 20-pin, for DS202	0690-1560-462
J205,206	Connector, 8-pin, through board	0690-1561-457
Q201,202,203	Transistor, MOSFET N-channel VN2222L	0685-0121-300
R201	Resistor, 11.5K, 1/4W, 1%	0680-2250-308
R202,203	Resistor, 680 ohm, 1/4W, 5%	6008-0005-682
R204	Resistor, 100K, 1/4W, 5%	6008-0005-105
S201	Switch, Batt/Circuit Test	0690-2502-005
S202	Switch, Alarm Silence	0690-2502-007
For S202	Socket, 28-pin	6006-0000-043
For S202	Spacer, .069"	6032-0000-012
S203	Switch, Batt Power	0690-2502-006
T201	Inverter, DC-to-AC	0690-2454-312
U201,202,203	IC, Shift Register, 4094B	0684-0400-042





Note: Paper backing to remain on outside surface of tape.



View A

Notes:

1. This circuit board subject to damage by static electricity. Handle only at approved static control workstation.
2. Use an anti-static container for storage or transport.
3. Install Q202, Q203 with maximum height of .250 inches.
4. S201, S202, and S203 must be aligned to fit through front housing.

Figure 34. Display Board Assembly (for edge-connected LCD display)

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